METALS and ALLOYS

The Engineering Magazine of the Metal Industries

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DOW

DOWMETAL

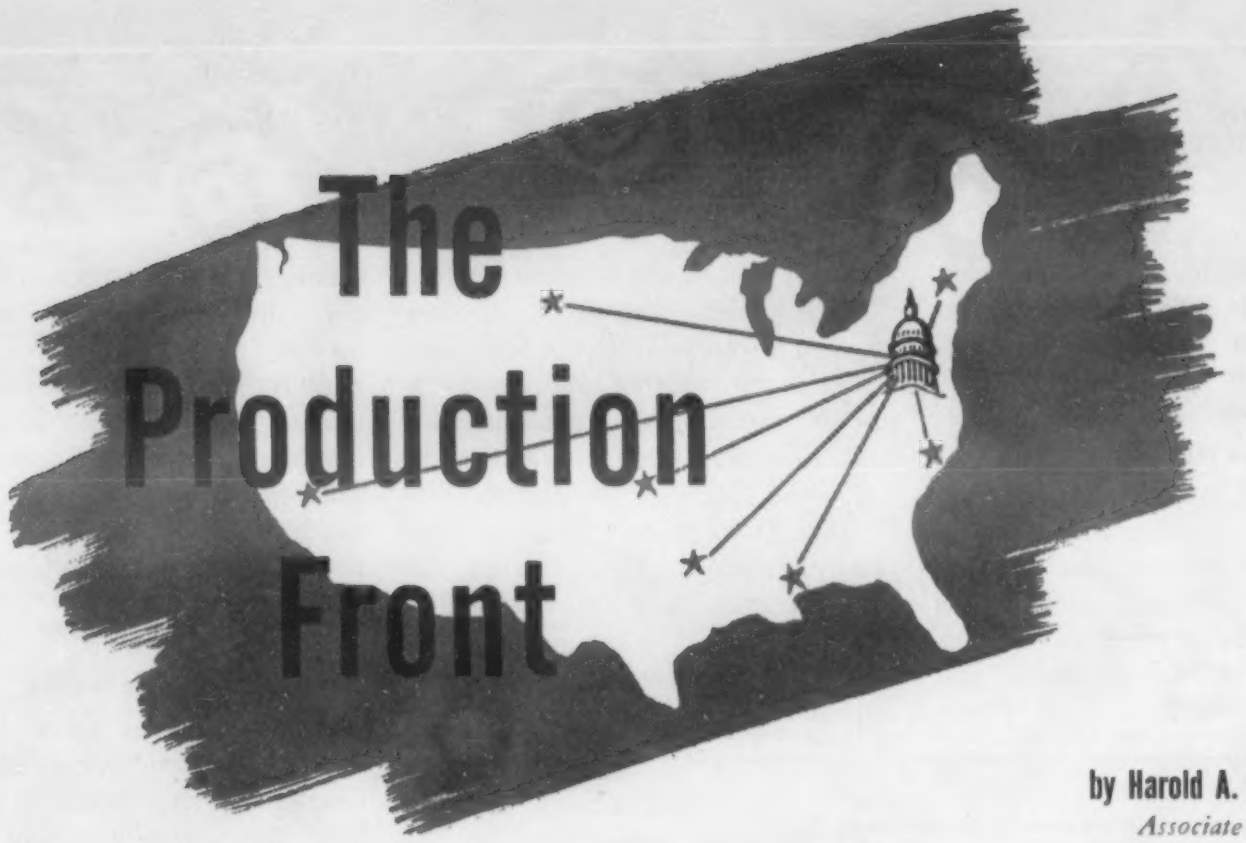
Magnesium, the extraordinary weight-saving metal that today lightens the burden of our fighting planes, is also a symbol of things to come. Designers are eager to extend its use when Victory brings release—to fill peaceful airways with freight transport freed of dead weight —to take full advantage of magnesium's lightness in the construction of products for factory, office and home.

Dow, major producer of magnesium, will be ready when that day of transition arrives—ready to cooperate as a source of magnesium ingots, fabrication facilities and engineering service.

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

MAGNESIUM

INGOT • CASTINGS • FORGINGS • SHEET • STRIP • PLATE • EXTRUSIONS



by Harold A. Knight
Associate Editor

Roosevelt, Churchill, Stalin, et al tell what we're fighting for. . . . Post-war planning is also an "escape" from the present. . . . Basic idea in planning is to estimate national income. . . . Absenteeism stems from "playing hookie" from school. . . . Japs have Zeros — so have we. . . . Yes, but war plants themselves are absentees. . . . England has but little to be absent for.

Each worker has 6½ h.p., against 3½ in 1917. . . . Steel bought by properties — the third new era. . . . Page the manicurist! . . . Trend to bombers means more steel and aluminum. . . . Subcontracting to be rejuvenated.

Internal combustion engine manufacture controlled closely by WPB. . . . Battlewagons must be simplified. . . . Don't laugh — that's captured Jap equipment. . . . Accidents in metal industry rise.

Production: But for What?

Would John Q. Citizen, under his welder's helmet, rather work on a gun that may help destroy ancient cities — perhaps a musty but ornate cathedral built in the Twelfth Century — or be hard-surfacing a ploughshare to turn up the sweet soil in the spring, when the cherry blossoms are pouring dainty perfume upon the lazy breeze and man and beast are joyous after the long winter confinements? Of course, a foolish question!

So we turn to our leaders for guidance in the present, and hope for the future. What kind of world are we fighting for?

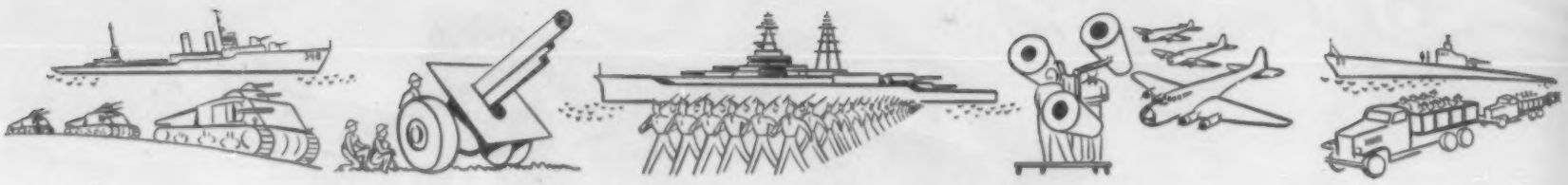
Our own President Roosevelt has stated: "We believe that any nationality, no matter how small, has the inherent right to its own nationhood." Winston Churchill has called for: "Restoration of sovereignty, self-government, and national life of the states and nations of Europe now under the Nazi yoke and the principles governing institutions in the regions and peoples which owe allegiance to the British Crown."

Joseph Stalin has called for "liberation of enslaved nations and restoration of their sovereign rights." Chiang Kai-Shek has expressed it: "The aim we and our Allies have set before us is freedom and security for humanity and its civilization. Our desire is to see proper importance attached to the interests of all races." Eduard Benes, president of Czechoslovakia, has stated: "We are fighting for some sort of international charter which shall embody the rights of man and be applicable to the peoples of all countries."

Post-War Planning, an "Escape"

Perhaps there is too much post-war planning on the part of both individual companies and governments. Yet there may be a fact overlooked on the part of those who scream: "Let's win the war first." Post-war planning is a certain out, or escape, from the present dark vistas. Some of the world's best masterpieces have been written in jail, the victim being inspired by prospects of release some day and the writing making more easy the present burden. So, perhaps, will peace planning make us more sturdy and resolute in prosecuting this war.

"Post-war planning will be greatly improved by taking into consideration the fact that our post-war economy will be a dynamic, not a static one," states Allen W. Rucker, president of a firm of business counsellors of Cambridge, Mass. "Thus, while an optimum goal of 110 to 135 billion dollars as an annual national income is desirable, management knows that as a practical matter, the annual national income will not be a constant figure at any particular level. It will fluctuate above and below some long-term trend line. Each firm should set specific objectives in terms



of sales, employment, purchases, products and building of plant facilities for several possible levels of national income."

Planning Based on National Income

Mr. Rucker has a table showing the wide variations possible in the U. S. national income, sectional income of New England, sales of one industry and sales of a single firm in that industry. Data cover all income levels from 70 to 150 billion dollars. Also, a ratio chart is used to show how post-war sales objectives can be readily related to national income, the chart being based on experience of 1929-1941.

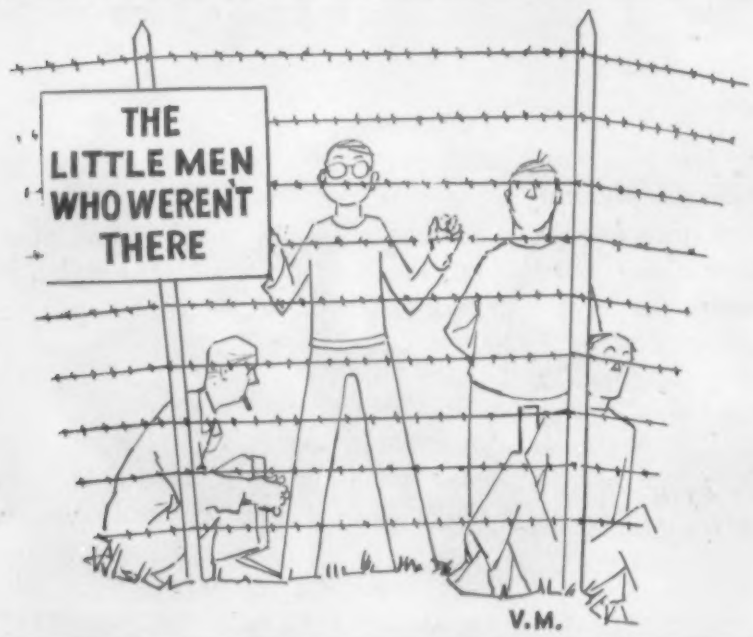
The printed plan lists five other practical objectives that can be plotted in relation to each income level and level of sales expectancy. These pertain to number of employees, material purchases, sales budgets and payrolls, budgeting sales by products and territories, and determining of plant facilities.

We hold no brief for Mr. Rucker's plan but merely would indicate with what precision many industrial leaders are thinking post-war.

But, to get along with today's production. Absenteeism is one of the main topics of the hour, just as strikes seemed the main hindrant a few months back.

Absenteeism is a very human failing. It often began early in the worker's life in the form of playing "hookie" from school. It is often an urge to escape from the humdrum of existence. Often the worker is not to blame. He is genuinely ill, has insurmountable transportation difficulties because of weather and distance from plant. Mothers have family responsibilities. Often the husband must take care of a sick wife.

The management can do much to combat it. It can help arrange convenient transportation, can install club rooms in the plant, give musical programs and generally make the plant as attractive as the worker's home.



American Zeros

by V. M. McConnell

Unpatriotic absentees
(From metal plants)
We ought to seize,
And fence them off
In some mirage
Completely hid
By camouflage,
Supplying each
A sign to wear,
"The little man
Who wasn't there."

"Absentee is a Murderer"

Sheldon-Claire Co., Chicago, has studied the psychology of absenteeism and inaugurated plans to build up public opinion whereby the finger of scorn is pointed at the shirker. One of the most effective appeals in a series of cartoons and talks states that the absentee may, in fact, be a murderer. Due to his absence, the war lasts longer and more American soldiers' lives are lost.

Fisher Body Division realized that irregular plant operations, whereby feverish work on Sundays and holidays, followed by shut-downs during normal working days, often gave workers an opinion of shiftlessness and irresponsibility on the part of management — hence, why should they, the workers, try to keep regular?

So the management has taken great pains to explain that business and manufacturing "flow" in war is much different from peace. There's the sudden change in design, lack of raw materials and abandoning of one munition for another.

Problem Not Acute in England

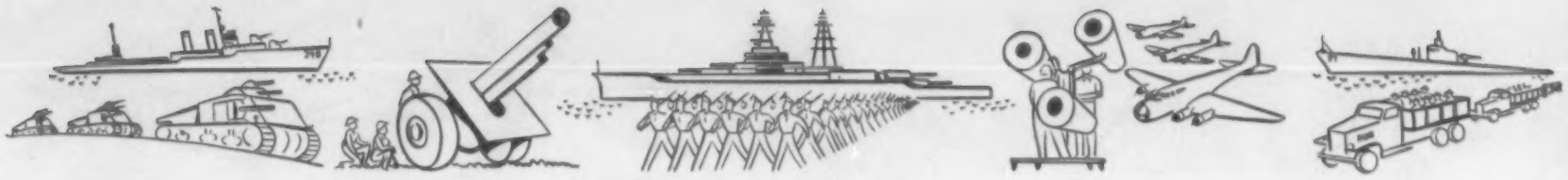
A group of us asked Col. John Jestyn Llewellyn, British Minister in Charge of Procurement in the U. S., how they handle absenteeism in Britain. "Usually absenteeism is caused because there is surplus money to be spent and surplus goods and amusements to buy. But there is hardly any of either in England, and everything is so strictly rationed." Then a twinkle came into his eye and his ruddy face became redder. "Of course, there is still one thing over there not rationed." (Loud laughter — we presume he meant love — and the sparkle in a maiden's eye.)

Appropriate to this department is a statement in a Government bulletin to the effect that at the close of the last war the American industrial worker had at his disposal an average of 3½ horsepower. Today it is 6½ h.p.

A man by his own physical efforts can supply only 1/10 h.p. Each worker today has the equivalent power of his own and 65 additional men. The 21,656,000 workers have 140,764,000 h.p. available, equivalent to the hand labor of 1,407,640,000 industrial workers.

Steel Bought by Properties, Not Analysis

And here's something interesting from *Steel Facts*, brain child of the American Iron and Steel Institute: "Wartime steel consumers are now beginning to order their steel by specifying the mechanical properties desired rather than by stipulating precise chemical composition. If this trend persists, it will mark the third new era in steel-ordering practices since the turn of the century.



"As recently as 1900 there were only three ways to order carbon steel — soft, medium and hard — the properties being merely a function of the relative carbon content." Chemical specifications came in right after World War I, the birth of alloy steel being the stimulant. World War II introduced scarcities and alternates. Buyers had to be content with results — let the producer worry about chemical elements and percentages.

From the same *Steel Facts* we learn that "Tool steel companies making sintered carbides (a tool material almost diamond hard) examine employees' fingernails. Since the carbides must be as pure as possible, no foreign matter must get in the 'mix.'" What a field day for manicurists!

Trend to Bombers—More Metals

Shift in emphasis from aluminum to steel has made Washington materials officials worried. Not that the aluminum program is a bed of roses, but estimates went out of the window as soon as long-range bombing had proved to be so successful. A big four-engine bomber uses 19 tons of steel (pre-machining weight), and a two-engine bomber consumes nearly 13 tons. The pressure is on the steel industry to keep the far-flung aircraft industry fed with high alloy steels, many of tool steel grades.

Fortunately, T. P. Wright, now the top man in the war aircraft program under Executive Vice Chairman Charles E. Wilson, foresaw the problem and began establishing warehouses for aircraft steel and other materials more than a year ago. There are now 22 such warehouses.

Recently, Mr. Wilson checked the inventory picture and confirmed the widely-known fact that the picture was as spotty as a leopard's skin. Some factories had excessive inventories, others had none.

Most of the aircraft manufacturers overbought in the early days of the war program, just to be on the safe side. Few had any experience in materials expediting in large quantities.

Important move of the WPB is to ask mills to pool orders received of alloy steels, and to swap orders with other mills to make heats more quickly.

Most talked of goals of American 1943 production — emanating from the White House, Congressional committees, and other official spokesmen — run from 100,000 to 105,000 airplanes. This compares with about 19,000 in 1941, and approximately 48,000 in 1942. But the weights have increased about 300 per cent over the 1941 average, because of the emphasis put on bombers, and because fliers are much heavier than they were. If the average weight for the 1941 program continues through the year, as is likely from present indications, we will need more than four times the amount of materials this year that we used last year. Already, responsible Government officials are predicting a goal of 150,000 aircraft for 1944 — if needed.

Thus, despite the magnificent job done to date in conservation and the greater pressure being applied by the Army and Navy for more conservation of critical materials, none of the men in the know about the nation's materials requirements are cheerful.

Those Faked Tensile Strengths

Defective war equipment has again raised its ugly head, this time in a subsidiary plant of one of the largest corporations in the world — a plant that makes an item among the most vital half dozen steel plates! Surely a situation to Hitler's liking!

Whatever adjustment, settlement or punishment results, it must be done after the most sober and painstaking investigation and thought. Perhaps the steel manufacturer is not the sole culprit — if "culprit" proves the proper term. Perhaps Washington has insisted too much on speed, with false emphasis placed there. Perhaps too many symbolic honors (Army-Navy "E's") have been bestowed on those plants that have given the most showy performance.

Perhaps, too, specifications of the Armed Forces are too stiff to be practical. Perhaps Washington puts too much pressure on at both ends of manufacture — forcing the "making of bricks without straw." (Under order announced March 24th, for instance, "each person melting alloy steel, including castings, must use alloy steel turnings in an amount not less than 8 per cent.")

Pulmotor Used on Subcontracting

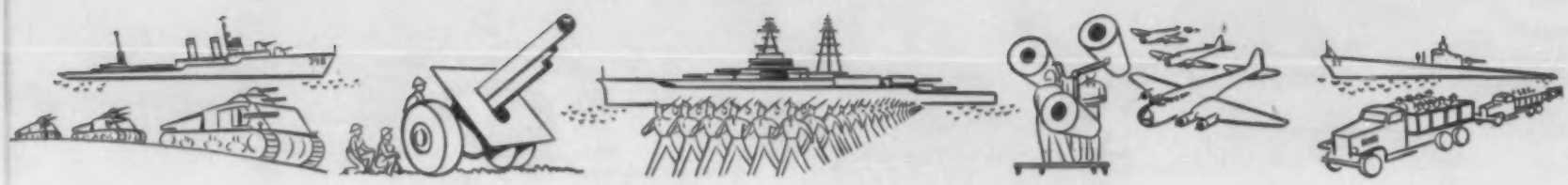
The old pulmotor was gathering dust, after several sporadic sessions with subcontracting, until Colonel Robert W. Johnson got up in the twin control role of the Smaller War Plants Corp., and the Smaller War Plants Division of WPB. He electrified Washington with identical letters to the secretaries of War and Navy, chairman of the Maritime Commission, and director of Treasury Procurement citing the law of the land.

He then gave a press conference — cocktail party to the members of the working press, which, from all accounts, was a "honey." He assured the reporters that he was going to see that the Smaller War Plants Act was administered.

His letters spoke of the "Congressional mandate" of the Act, and he reminded these high-placed gentlemen that as chairman of the Government corporation, he wanted to know by April 7, from 252 major Government contractors:

1. The number and dollar volume of prime and subcontracts;

2. Methods being used by these contractors to increase subcontracting; and



3. What methods are being used to insure subcontracting being done on a fair and equitable basis.

The odds are with the Colonel, primarily because he believes in subcontracting, and because subcontracting is politically potent. It means something to millions of constituents of all Senators and Representatives — many of whom face bankruptcy or loss of jobs.

Chairman of Johnson & Johnson, New Brunswick, N. J., Col. Johnson was formerly the hard-hitting chief of the Army's New York Ordnance District. His success in subcontracting is on the record.

WPB Steers Gas Engines, Diesels

Internal combustion engines, except for aircraft and motorcycles, can henceforth be manufactured only at the direction of WPB. Thus, controlled production will be given an important tryout in an industry with nearly 300 manufacturers.

Limitation Orders L-293 (Feb. 26) and L-254 (Mar. 4) mean that even the military services will be required to place orders with certain specified factories for certain type of engine. Furthermore, several manufacturers have been ordered to reduce their lines to only one model, to conserve supply.

WPB found that some engine builders had backlogs requiring up to 30 months to complete, while others were practically shut down, despite the demand for gasoline and diesel engines. They also found many unused facilities for components.

Toughest problem is to get enough capacity for steel cylinder castings and large crankshafts for heavy-duty diesel engines. A committee of industry engineers have recommended specification changes to permit cast steel crankshafts instead of forgings, at least for several types of diesels.

Highspots of L-254 include: Minimum performance requirements providing at least 85 per cent of the manufacturer's published claim, and simplification requirements which forbid automatic chokes except when remote control of carburetors are specified. Manuals henceforth shall be 6 x 9 in., and will be illustrated with drawings or photographs — but not both. Spark plugs may be either 14 or 18 mm.

We Must Simplify the Battlewagons

There has been a lot of civilian criticism of the lack of standardization in the Navy's shipbuilding program. Most cogent has been the opinion that battlewagons had too many types of diesel auxiliary power units.

Vice Admiral Samuel M. Robinson, chief of Ordnance Material and Procurement, and formerly chief of the Bureau of Ships, will soon be calling on industry engineers to act as advisory groups on specific problems — according to our best information.

Obviously, only those engineers who have been designing battleships, cruisers, submarines, and other naval vessels could be expected to have any valuable knowledge of over-all Navy engineering problems. Aside from the production involved in producing a wide range of engine types for auxiliary power needs, non-interchangeability of replacement parts and maintenance generally are immediately serious.

It is probable that some of the readers of METALS AND ALLOYS will be called upon by the Navy if Admiral Robinson decides to use engineers of industry to help him get Navy procurement on a new course.

Fruits of Enemies' Production Fronts

We had the pleasure of inspecting captured enemy war equipment one day recently. Though one cannot reveal many intimate details because of war exigencies, a few generalities can be told safely.

Japanese equipment is often laughable, and one almost pities the dwarfed little heathen. It seems hardly fair to be shooting at them — they with their wooden bullets for jungle warfare where ranges are short; their cannon wheels made of scrap iron with no two pieces quite the same size. Designs of several light guns, such as mortars, seemed queer from our standards.

German equipment was much better. Superb were "needle" bearings used in the tractor treads of a German troop carrier in the African desert — the tractor equipment so sturdy that the Americans can't throw it off its tracks. Our big guns were better than the corresponding German models — more compact, sturdy, simple in design, and with gunners more protected.

One was surprised by the large variety of mines and booby traps, which are much more important than during the first war. They are starting to make housings of plastics, so that the detector machines of the enemy can't locate them through magnetic impulses.

An Italian road mine was indeed a crude affair. The housing was an oblong box, to be buried transversely across a road. But sand or rain would in a few hours make it impotent.

One saw the light guns that the United Nations are dropping by parachute upon the Occupied Nations, guns that are made easily by mass production methods such as stamping.

Accident Rates Rise Sharply

Accident rates in the metals industry are growing, possibly because of the many new hands. For the industry as a whole, the frequency rate for July-January, 1943 was 8.43, an increase of 9 per cent over the first seven months of the 1942-43 contest. Heavy machine shops showed the only improvement, a drop of 2 per cent.

The most severe increase was in rolling, finishing and fabricating, or by 24 per cent. The frequency rate in the foundries was highest at 22.03, up to 7 per cent. The contest is held under the auspices of the National Safety Council, Inc., Chicago. Certainly this is all loss of manpower.

Secondary Metals

The author of our leading article in this issue—"Non-Ferrous Secondary Metals"—calls attention to some facts which we feel deserve further emphasis. It is true, as Mr. Willard so succinctly states, that "the secondary metal industry suffers the disabilities of a traditional Pariah. Though its essential function is reluctantly recognized, those engaged in it are not quite acceptable socially. . . . The engineering talent which has been devoted to the recovery of metals from ores has hardly touched the secondary resources."

We subscribe to the suggestion that metallurgical development in the secondary metal industry may have been handicapped because of this situation. The primary industry has looked upon the secondary as "a nuisance" rather than as "an essential partner." Perhaps the terms "scrap" and "junk" have exerted a bad influence. In any event, the scarcity of metals due to the war has emphasized the value and character of this secondary reservoir and really put it in its rightful place for "scrap metals are the most readily available source of new metals." The supplies of tin, copper, lead, zinc, etc., would have been even smaller were it not for the work done in reclaiming them.

In the ferrous field some striking developments have taken place. Scrap iron and steel, which have been buried for years in dumps in steel mill yards in the form of skulls from ladles, drippings from furnaces, etc. is now being eagerly sought and reclaimed—the total, could it be ascertained, adding substantially to our vital needs.

The present metallurgical status of the non-ferrous secondary metal industry is clearly and interestingly portrayed by Mr. Willard. Doubtless as time goes on, improvements in the salvaging of these metals will be developed by interested metallurgical engineers. It is probably certain, if not it should be, that the "social position" of this industry after the war will be on a plane higher than ever before.

We have wasted our substance in riotous disregard of the future. The war is teaching us a lesson in the use and conservation of metals and other materials.

—E. F. C.

Metal Prices in the Post-War World

With the recent reduction in the price of magnesium metal, a metal which sold at $3.50 per lb. when Dow Chemical Co. first introduced it in 1915, by two cents per pound to 20½ cents for the pure grade and other classifications accordingly, it is again appropriate to speculate on competition among metals

Critical Alloys Lost Forever

If you do not segregate scrap at the source. Each handling increases the difficulties of reclaiming valuable war metals.

Every scrap program should include careful segregation and identification methods that will conserve critical alloying elements and metals. The most effective way to segregate scrap is at the source—at the machines where it is produced—because the danger of mixing increases with each handling. Ferrous and non-ferrous scrap should be collected in separate containers, and each class of alloyed iron and steel scrap should be kept separate so that their alloying contents can be returned to service.

There are many reasons why scrap segregation is of vital importance to America's war effort:

1. Most war equipment requires the use of alloys, many of which are scarce.
2. Segregated and identified scrap can be used for making alloy steels of the same or similar analysis.
3. If alloy scrap gets into a charge of carbon steel, not only are the alloys lost, but the heat may be rejected.
4. Mixtures of various kinds of alloy scrap are often harmful and the alloying elements are completely wasted.
5. Non-ferrous scrap, mixed in iron and steel scrap, not only wastes critical non-ferrous metals, but may cause the rejection of steel heats.

Great quantities of alloys are needed for the production of tanks, guns, planes, etc. Help steelmakers—help manufacturers—help our fighting men, by segregating and identifying every pound of scrap you produce.

Check your scrap segregation methods today—improve them if possible.

ARMY E NAVY

Dedicated to Victory

INLAND STEEL CO

38 S. Dearborn Street, Chicago • Sales Offices: Milwaukee, Detroit, St. Paul, St. Louis, Kansas

on a price basis in the post-war period.

Meanwhile aluminum prices are tending downward, ingot metal being now 14 to 15 cents, whereas for several years prior to this war it sold in its 20's. Moreover on March 1 the Aluminum Co. of America reduced prices on semi-fabricated and fabricated forms.

Copper, at 12 cents, is but little cheaper than aluminum and in fact it is often predicted that the price of the latter will get down to copper's present level. And we will do no more than mention at this moment the competition among metals and non-metals such as plastics, plywood, glass, fibre, etc

For many months now our senses of prices, costs and values have been dulled in the urgency to produce munitions on an unprecedented scale. Chief competition among metals now has revolved around physical properties—whether the lead or zinc will do efficiently the job originally done by copper or aluminum. Often this competition has disappeared and we have been compelled to use what metal was available.

But even the blind can foresee the competition coming, with production facilities overexpanded. Must the Government step in and impose a floor on prices so that declines will not be too destructive? Or, shall some Government agency, such as Metals Reserve Corp., buy up surpluses and form a pool, releasing its contents gradually?

Or, shall nature—or rather the free play of supply and demand—be allowed to take its course—let each metal stand on its own legs and merits? After all, our country has been reared on healthy competition. Low metal prices will help the metal consumers and —if the producers can meet their costs—will tend to broaden the base of the market. The economics of supply, price and consumption of metals is indeed complicated, but rigid governmental price control for metals would be an unfortunate peacetime alternative for flexible, market-sensitive price conditions.

—H. A. K.

Metals and Alloys' First "Achievement Award" Postponed

In its October, 1942 issue (page 598) this magazine announced the "Metals and Alloys Annual Award for Engineering Achievement in the Metal Industries"—an award to be made each year to a company in either the metal-producing or metal-working industries adjudged to be responsible for the greatest recent engineering achievement in its field.

Although the announced closing date for the submission of entries for the 1943 Award—July 1, 1943 —is still several months away, interest in the competition is already sizable. It is with the greatest reluctance, therefore, that we have decided to postpone the conferring of the first of these annual awards until after the war has ended. One powerful reason above all others impels this decision—the necessary technical secrecy that surrounds most of the outstanding current production and design achievements in our field.

Practically all the major engineering developments in "production, manufacturing practice or design" involving metals or metal products since 1941 have been of a war-product nature. The technical details of these achievements are generally not available for either Award consideration or publication; the very *existence* of some achievements of Award caliber cannot be discussed until Victory has been won. Under these circumstances (1) we could hardly arrive at a "fair" Award decision with so many companies unable to reveal the details or even mention the nature of their engineering achievements and (2) even if these details could be privately discussed with us for judging purposes, we should be unable to justify our decision with a published account of the achievement, and one of the chief purposes of this Award—the stimulation of continuing technical advance through example—would be obstructed.

Beyond this, most manufacturers and their engineering and production staffs (not to mention the available judges) are too busy winning the war to give much time to recounting *how* they are winning it.

But it will be won and we repeat our October-issue declaration—"particularly in this *war-of-metals period* will the force of recent and current technical achievements be felt with telling impact." So mark time, you engineers, metallurgists and production executives! Your achievements *will* receive the full and fair consideration at the war's end that is now impossible; the awards *will* be made, and on a different and more interesting basis than originally announced; and we *will* ultimately publish the best of the war-winning engineering achievements in the metal industries that—come peacetime—will then be ripe for publication.

Until then, we'll continue seeking and cataloging the achievements in the field. And you—keep your records well, remember the judgment day is coming, and plan the entry that your company will eventually make for this important engineering award.

—The Editors

(Editorials continued on page 776)

Miscellaneous copper-bearing scrap on its way to the blast furnace.

Non-Ferrous Secondary Metals

—An Outline of Their Metallurgy

by F. W. WILLARD

President, Nassau Smelting & Refining Co., New York

Industrial "Cinderella" though it may be (as Mr. Willard implies) the secondary metal industry is vital to our production economy, and especially so in these days of copper, zinc and tin shortages. This authoritative article reviews current metallurgical practice for various secondary metals and discusses some of the technical and economic problems the industry must face today — and tomorrow. —The Editors

Separating lead alloy sheath from insulated copper core of scrap telephone cables.

THE SECONDARY METAL INDUSTRY suffers the disabilities of a traditional Pariah. Though its essential function is reluctantly recognized, those engaged in it are not quite acceptable socially. To what extent this has handicapped metallurgical development is difficult to say. The engineering talent which has been devoted to the recovery of metals from ores has hardly touched the secondary resources.

The scrap business is considered to be unclean and not without reason; but scrap metals are generally the most readily available source of new metals. The primary industry has treated it as a nuisance instead of an essential partner.

The term "secondary metal" was coined by some sensitive soul to spread a cloak of dignity over an unclean thing. "Scrap" and "Junk" are patois of the gutter. Because of this scrap metals are not treated with the consideration their real value warrants, and their metallurgy is seriously handicapped by careless and slovenly handling, degrading instead of upgrading, because it is "nothing but junk."

Types of Secondary Metal

Secondary metals are classified in two general groups:

(a) Waste resulting from the necessary processing (fabrication) of metals and alloys into articles of commerce.

(b) Waste rescued from structures, mechanisms, utensils after they are worn out or become obsolescent.

Dr. W. R. Ingalls has given to these two groups the most useful names. The first he calls "process" scrap, the second "demolition" scrap, pointing out that the first adds nothing to the current supply of metals while the second is a high grade mine.

Inasmuch as the bulk of secondary returns is in the form of alloys of two or more metallic elements, treatment is naturally directed toward re-use in the same or similar alloys. This involves remelting, some refining, and always some adjustment of composition. Obviously this results in a minimum loss of the metallic constituents. Remelting may be done in

Pouring copper base alloy foundry ingots from a reverberatory furnace.

crucible, reverberatory or electric furnace. Crucible and electric furnace offer little or no facility for refining, so for secondary charges requiring some fire refining and considerable adjustment of composition, the reverberatory is preferred and most generally used.

In the non-ferrous field it is hardly necessary to say that refinery practices are built around the treatment of copper and lead base alloys. Aluminum and its alloys receive separate treatment preferably in plants constructed for them exclusively. Tin and antimony are generally treated with lead-base alloys. Nickel, being involved chiefly in ferrous alloys, is not included in this study except as a minor problem in certain copper-base alloys.

Zinc is of course, a major alloying element in the copper-base group, and all metallurgy of the group must take it into account. Aside from this function, secondary zinc alone has a peculiar place.

The lead-base group is in two parts, of which in the past lead-tin has been of some importance. Now lead-antimony is probably more significant.

Technology and Economics

The effectiveness of secondary recovery is a direct function of the effectiveness of classification and segregation of scrap. Existing commercial practices are conditioned by the economics of metal production in a free market. This has generally left a residuum of metal-bearing by-products which could not be profitably treated notwithstanding that they carried significant amounts of metal values, amounts generally much greater percentagewise than the richest primary ores.

Metallurgical technology is not impotent to solve this problem. Several techniques are available, but these residues are dissipated geographically. They occur in a relatively large number of widely separated localities, no one place having a substantially large portion of the total. They have not been worked for their values for the same reason that certain very rich but small ore bodies have not been worked. Theoretically, here is waste. Practically, it is cheaper to produce primary metal from lower grade ore bodies where those bodies are of great magnitude.

In summary, the current metallurgy of secondary metals is subject to the exigencies of its economic position. It has changed and will continue to change with the shifts of that position.

War brings its inevitable controls, and to the extent that those exercising such controls understand the economic relation of secondary to primary metal production, the controls operate without too much delay. Unfortunately that kind of understanding has not always been located where it is needed, and division of responsibility and authority has too often obstructed secondary metal movement.

To treat adequately current technical practices in the recovery of metals from scrap needs a monograph of some volume. What follows is a bare skeleton.

Copper and Copper-Bearing Scrap

Copper and copper-base scrap follow the procedures outlined below:

No. 1 Copper Scrap, clean, (99% assay), is used:

(a) In place of refined primary by foundries and by brass ingot makers in copper base alloys either by electric furnace, crucible or reverberatory practice.

(b) Fire refined in reverberatory to meet electrolytic standard under A.S.T.M. B-5-27.

(c) Fire refined in reverberatory to make a foundry grade of copper 99.50 per cent or better.

Copper Scrap—92 to 98.5 per cent assay:

These grades of scrap include No. 1—98½ per cent assay; No. 2—96 per cent assay; and No. 3—light copper 92 per cent assay. They are all treated similar to No. 1—99 per cent assay, except under (b).

By products of these operations are generally furnace slags which may assay 50 per cent Cu with appreciable amounts of tin and lead. They normally go to the blast furnace to produce what is known as black copper or blister which is treated for recovery of copper by electrolytic refining.

Skillful treatment of these slags in the blast furnace with other copper bearing scrap (see below) can produce a copper base alloy sufficiently uniform and bearing appreciable quantities of tin which can be used directly in the reverberatory to make standard red brass foundry alloys. This is important as a conserver of the important metal values and expediter of copper run-around.

Copper-bearing scrap (5% to 60% Cu assay):

This may be miscellaneous mixtures of ferrous metals and non metals with copper and is made up of both process and demolition scrap. It includes copper and copper alloy clad steel, insulated wires,

Making high tensile bronze from secondary copper in rocking arc electric furnace.

assemblies and parts carrying copper, bronze, brass, nickel silver, etc. Normally this scrap goes to the blast furnace and converter where it is run down to a blister suitable for the refinery anode furnaces.

Copper-base alloy scrap:

This consists of both process and demolition scrap and is chiefly red brass scrap bearing varying amounts of lead, tin and zinc, with about 78 per cent Cu minimum assay; yellow brass scrap 70 per cent Cu assay maximum, a large part of which is process turnings and punchings both leaded and non-leaded.

Theoretically this process scrap should go back to the brass mills for use in new brass products. Such use involves a careful and sure segregation of qualities at the scrap source. Where there is uncertainty, the brass mills are naturally reluctant to use it.

Leaded brass scrap is made up of a large volume of turnings which brass mills do not like to use in their furnace charges in large percentages. Secondary smelters try to keep the percentage down to 50 per cent with the balance "solids" (rod ends, etc.), but they can work to 75 per cent turnings with increased shrinkage losses. They do, however, operate 100 per cent scrap charge which brass mills are reluctant to do.

Even with the best practice, considerable process scrap is mixed or otherwise contaminated and goes to the blast furnace, reverberatory furnace, converter and electrolytic plant with considerable loss of alloying elements such as zinc, tin and lead.

Red brass scrap largely goes to the secondary smelter where it is remelted, refined, and brought up to standard specifications usually in reverberatory practice. By-product slags go to the blast furnace for recovery of metal values.

Miscellaneous high copper alloys (hot and cold worked) generally go back to the brass mill. When they go to the secondary plant they are generally used to enrich the reverberatory charges of standard red brass alloys.

Yellow brass demolition scrap is remelted and brought up to grade to produce the commercial No. 1 yellow ingot for general brass foundry use.

Market conditions may, however, divert appreciable quantities of this scrap to the custom smelter where it goes through reverberatory furnace, blast furnace, converter, and electrolytic refinery, with some loss of zinc.

Nickel silver scrap ordinarily is treated the same as yellow brass demolition scrap, either melted to a foundry alloy, or sent to the custom smelter for copper recovery. Nickel recovery is in the form of salts from the electrolytic copper refinery. The tonnage is not large and the recovery of pure metallic nickel is not practical. There are, however, no serious technical problems involved. The industry awaits with interest and some skepticism the Government plan of recovery of the nickel as cupro-nickel alloy. It wishes the Government well, for if the method proves to be technically sound, it may help to solve a small but pestiferous problem of the secondary industry.

When all is done for recovery and reuse of secondary copper and copper bearing alloys, there remains an end product carrying from 5 to 10 percent Cu which cannot always be economically recovered. The amount of this is largely determined by the fidelity of the classification of scrap. Where run-around is concerned, there should be a minimum of mixture and contamination because it is possible to segregate it at the source. Demolition scrap can be sorted more accurately and intelligently than is the common practice. Recovery of copper from these residues is not a problem of technology but of dissipation.

Pouring fire-refined secondary copper into standard ingots.

Diversion of practically all copper to war uses has inevitably changed the conditions of secondary recovery by altering end uses. War stimulates new technology, and metallurgy is of course no exception. We can anticipate that copper metallurgy will be affected in some important ways. For example, it has not heretofore been attractive to develop and install plant to recover copper from copper-clad steel because the total volume of such scrap is limited. Under the exigencies of war, copper and copper clad steel are being produced in prodigious quantities. The recovery of resulting fabrication "run-around" has become a major necessity requiring specialized plant. Some of these technologies may survive in peace time practices.

Zinc

The recovery of zinc from its copper alloys has been outlined above. Where blast furnace and converter operations are necessary, some of the zinc is recovered in bag-house or Cottrell as fume—mostly an impure oxide, and is used for filler, pigment, insecticides, or other zinc chemicals.

Secondary zinc of the demolition class has not heretofore been large from a tonnage standpoint. However, the admirable development of zinc base die casting metallurgy began to be felt prior to 1942 by appreciable returns of demolition die cast especially from the automotive field. In peace times this can be expected to become important, and improved metallurgy will come with it as an economic necessity. Now it is recovered by (a) remelting to a second grade die cast slab (not an intelligent procedure), or (b) redistillation to recover zinc as slab or metallic dust. Practice under (b) does not yet provide adequately for recovery of contained aluminum.

Heretofore, the substantial tonnage of secondary zinc has been the heavy slab dross and the surface skimmings of the hot dip galvanizing process. In peace time nearly half of zinc production went into galvanized products. In the process some 13 per cent came back to the secondary smelter as dross and skimmings and provided a suitable raw material for zinc chemicals and zinc dust for the chemical industry. The dust is produced by controlled distillation from large retorts into air cooled chambers where the vapor is condensed as a powder. The heavy slab dross is particularly suitable for this kind of operation.

Some process zinc scrap as well as demolition is melted in open kettles and cast into slab. Such treatment results in variable quality, usually bad. On the other hand, redistillation in modern stills can and does produce acceptable qualities of secondary slab generally superior to Prime Western and sometimes approaching the high grades. This is known in the industry as intermediate slab zinc.

Lead

Secondary lead is largely of the demolition class and consists of two large tonnage items, namely, spent accumulators and cable sheathing from power and communication cables removed from service.

These leads are usually alloys with small and varying amounts of antimony and are recovered in open kettle operations where they are drossed and skimmed and necessary antimony added to bring them back to specification for re-use.

There have been times when it seemed to be economical to remove the alloying element, recover it as metal or compound, and produce a soft lead equivalent to primary quality. The method is some variant of the Harris process wherein the scrap is treated at relatively high temperature with strong agitation in the presence of molten caustic soda and an oxidant. Tin also is removed from lead by the same method.

Where large tonnages of battery plates mixed with battery oxides are recovered, blast furnace practice is preferred where re-use in new battery plates is intended.

Drosses and skimmings from these operations generally carry higher amounts of the alloying element than the original scrap. They are treated in blast furnace or reverberatory units to produce higher antimonial content alloys, alloys which can be used in lead base die casting products.

A smaller but significant quantity of secondary lead is recovered in the processes of recovering secondary tin where lead-tin alloy is the end product.

Tin

Secondary tin sources have been of three principal kinds, (a) drosses and residues from the manufacture of tin plate by the molten or hot-dip method, (b) demolition scrap, scrap from used bearing alloys, solders and other miscellaneous lead base alloys and a few tin base products such as block tin pipe, (c) tin plate scrap chiefly from the container manufacturing plants.

Secondary smelters generally recovered tin in some form of lead alloy for use in soft solders (the largest usage), lead base and tin base babbitts, type metals, etc. Drosses and residues were treated in reverberatories with reducing agents in the presence of lead drosses where the desired end product was a solder or other lead bearing alloy. An impure alloy was thus produced which was kettle refined and brought to specification composition. Progressive smelters introduced substantial improvements, one of which was the production of an electrolytic solder of high purity. Another successful method of making a lead-tin solder base from drosses and residues, and from primary cassiterite concentrates, is a continuous electric resistor furnace. Certain other secondary smelters use the chlorine method of recovery of tin from mixed and highly impure residues and secondary alloys. The chlorine method is, of course, old. As noted under Lead, a form of the Harris process is used to remove tin as well as antimony from its lead alloys.

An old and well known method of removing from or concentrating tin in lead alloys is known as differential oxidation. The tin bearing material is melted and brought to a bright red heat in a suitable reverberatory and the melt blown with air. The tin drosses out with a portion of the lead leaving a

Copper wire bars, fire refined from No. 1 scrap line wire and cable core. These bars meet requirements of A.S.T.M. B-5-27.

soft lead practically equivalent to primary lead, and the dross is then treated by reduction as described above to produce a tin-lead alloy base having 15 to 30 per cent tin content of the original material.

The recovery of tin from tin plate scrap is a highly developed technology. Under pre-war practice the tin plate carried about 1.35 per cent Sn. Formerly this was removed by treatment with dry chlorine gas and the recovered tin marketed as the tetra-chloride, finding a ready market in the treatment of natural silk fibres. The invasion of artificial fibres left the detinner without a market for his tin as tetra-chloride. Thus he was compelled to devise entirely new methods of detinning to recover tin either as metal or as oxide for the ceramic industries, or as a soluble salt for the use of electroplaters.

Thus out of necessity was developed the present method of detinning by digestion in hot caustic soda in the presence of an oxidant, the purification of the sodium stannate and its reduction to metal by direct electrolytic deposition or precipitation as oxide by treatment with CO_2, and the reduction of the oxide to metal by the classical fire smelting methods, or the sale of the oxide directly to enamelers who use it as vitreous enamel opacifier.

These detinning operations employ some of the most progressive engineering in the metallurgical industries. Following most modern chemical engineering unit processes, the detinners have produced economically two very high quality secondary metals; namely, an electrolytic tin of a purity averaging better than 99.95 (the finest tin ever marketed), and a clean, low phosphorus steel scrap especially acceptable to the open-hearth steel operator.

The necessity for restriction of the use of tin has in the short space of one year profoundly modified the secondary metal industry. The rapid change to electro-tin plate using half as much tin and producing little or no process waste (drosses and skimmings), the development of low tin or no-tin solders, have changed the demand and method of supplying it from secondary tin sources. The detinner is faced with not only a diminishing supply of raw material but with a rapidly diminishing tin content, making his industry more than ever dependent upon the demand for detinned steel plate scrap.

Of course it is hazardous to make predictions under present confused conditions, but the future requirements of tin under peace conditions bid fair to be greatly curtailed. Best informed men in the tin plate and the container industries believe that the electro-tin plate has come to stay. Competent metallurgical engineers believe the new metal jointure alloys will not be discarded after the necessity disappears. These are the two largest outlets for tin. To win them back tin will have to be sold at a very attractive price, and high cost tin ore properties may meet adversity.

Antimony and Others

So far as secondary antimony is concerned, the methods of recovery are outlined under the subject of Lead. Nearly all antimony is recovered in its lead alloy form. A small and variable quantity is recovered in the Harris process as sodium-antimonate which, before war restrictions were applied, found a limited outlet in ceramic industries.

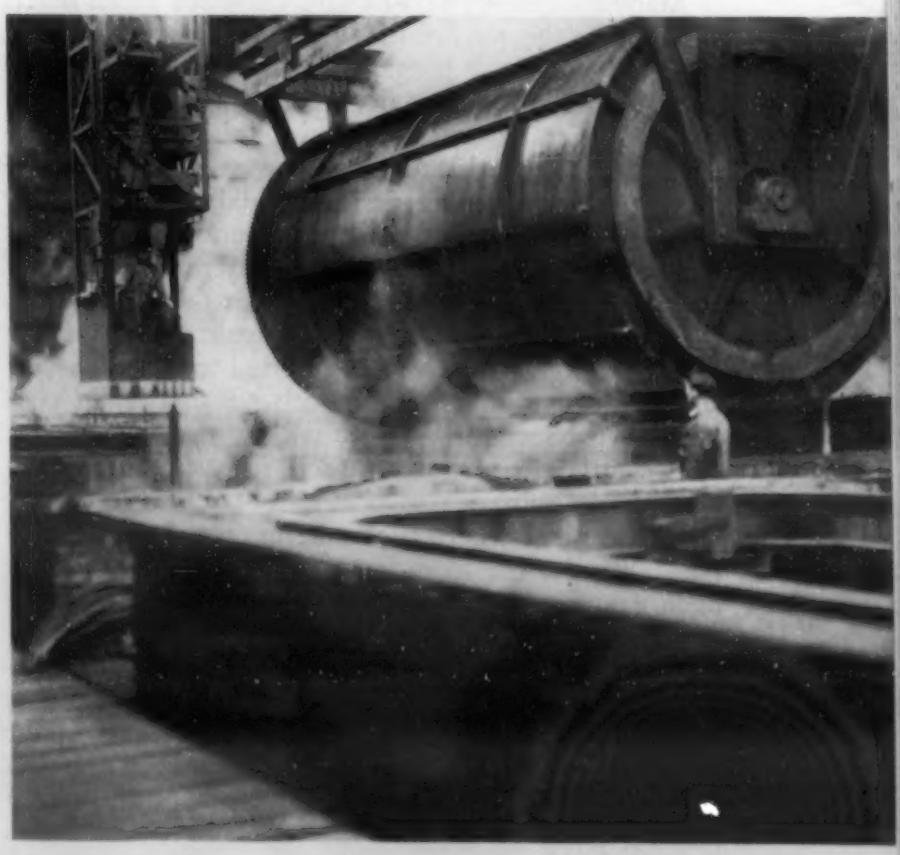
Methods have been worked out and applied to the production of antimony regulus from some secondary sources, but much of the domestic production is derived from primary sources such as the dry belt ores of Idaho and certain types of Mexican and South American bullion.

Arsenic, bismuth and cadmium are not specifically the objective of any existing secondary technology.

Alloys the Vital Thing

The characteristic of metallurgy and metallurgical engineering today is the science of alloys. The prime objective of secondary metal recovery is to avoid the costly and wasteful process of tearing alloys apart to recover their pure constituents. Consequently the economy of the future will be directed toward the maintenance of the identity of the alloys through their fabrication peregrinations and their useful life so that when they are returned to re-use, they can be put to work again quickly and economically.

The voracity of war for metals has thrown a strong light on our peacetime wastefulness and carelessness in the preservation of the identity of our secondary supply of metals. We are trying clumsily to do something about it. It will not be done very effectively until the economic incentive becomes real. Directives from a central government will not solve the problem.



Digester drum of tin plate scrap going to the caustic tanks. (Courtesy: Vulcan Detinning Co.)

Arc Welding in Wartime Redesign

On every hand we hear horrible cries that the light metals are going to put the steel mills out of business, come peacetime. So it's refreshing (even to the aluminum manufacturers, we are sure) to have this factual case history of a redesign to save weight and critical metals that involved a switch from heat-treated aluminum castings to welded steel sheet. The story won for its author an award in the James F. Lincoln Arc Welding Foundation's recent $200,000 contest. —*The Editors*

by S. BIRKLAND

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THE SHORTAGE OF CRITICAL MATERIALS and the unsatisfactory delivery conditions, growing out of the present war emergency, undoubtedly has given to welding, at least as far as the general machine industry is concerned, a greater impetus than any other single factor in the years elapsed since its introduction into the engineering field.

Many companies who had never before given much thought to the possibilities of welding, or who had shied away from it because they "were not equipped for welding," found it necessary to use this method of production in order to continue their manufacturing. It is true that in many cases when, for the above reasons, welded designs had been substituted for cast designs, even the production of the former has had to be stopped due to priority restrictions, but it is probably just as true that when the time comes that all material shall be "free" again, many of the welded designs, which were resorted to out of necessity, will be found to have such advantages in economical production that they will be retained permanently rather than be discarded for a return to the original design.

In the plant where the writer is employed, which plant handles the manufacture of machines for producing and sealing of cans and containers, a great many parts for these machines were made of heat-treated aluminum alloys. The manufacture of containers nowadays is done at such a great speed that it is necessary, if the machines are to run without frequent breakdowns, that lightweight construction be used in practically all reciprocating and rapidly moving parts.

Aluminum Alloys Originally Used

Until the present emergency most of these parts were made of cast aluminum alloys of high tensile strength, this being the material that most naturally presented itself to meet the conditions. As it became more and more difficult to obtain satisfactory deliveries of heat-treated aluminum, other means of producing lightweight parts had to be resorted to.

The first, and simplest, thought was to substitute steel castings or bronze and reduce the cross-sections so that the weight of the part would remain as close to its former value as possible. However, it was hardly ever possible, when using this substitution method, to bring the weight of the bronze or steel casting closer than 50 per cent, and generally 100 per cent, over and above that of the aluminum casting.

The next substitute, then, was welded sections. Although this was resorted to with some trepidation, due to previous bad experiences with production costs on occasional jobs, it produced some highly satisfactory results. While it had not been possible to do an economical job of welding on previous, occasional jobs, apparently due to not approaching the job in a production-like manner, it soon became evident that, very often, the design of the part could be radically changed without impairing its basic functions. This, together with the use of necessary fixtures and setups for quantity production, would produce a welded job more economical and, in many cases, even *lighter* in weight, than the aluminum-cast product. As an example of what can be accomplished the vacuum chamber door, shown in Fig. 1, is illustrative.

This door is used on a machine, Fig. 2, which seals cans under vacuum after they have been filled. Since the door has to be opened and closed by the operator for every can that is inserted into the chamber, it is obvious that, if the operator is to maintain a fair speed of operation, the door, which is 21½ in. high and 14¼ in. wide, must be of fairly light construction. Otherwise the inertia of opening and closing it would be so great as to slow down the operation.

The original door was made of heat-treated aluminum. The hinges were cast in one piece with the door, but the handle, which is a commercial product, was held by screws to machined pads on the outside. The curved design was used to resist a maximum vacuum from the inside. The weight of the door, complete, was 23½ pounds.

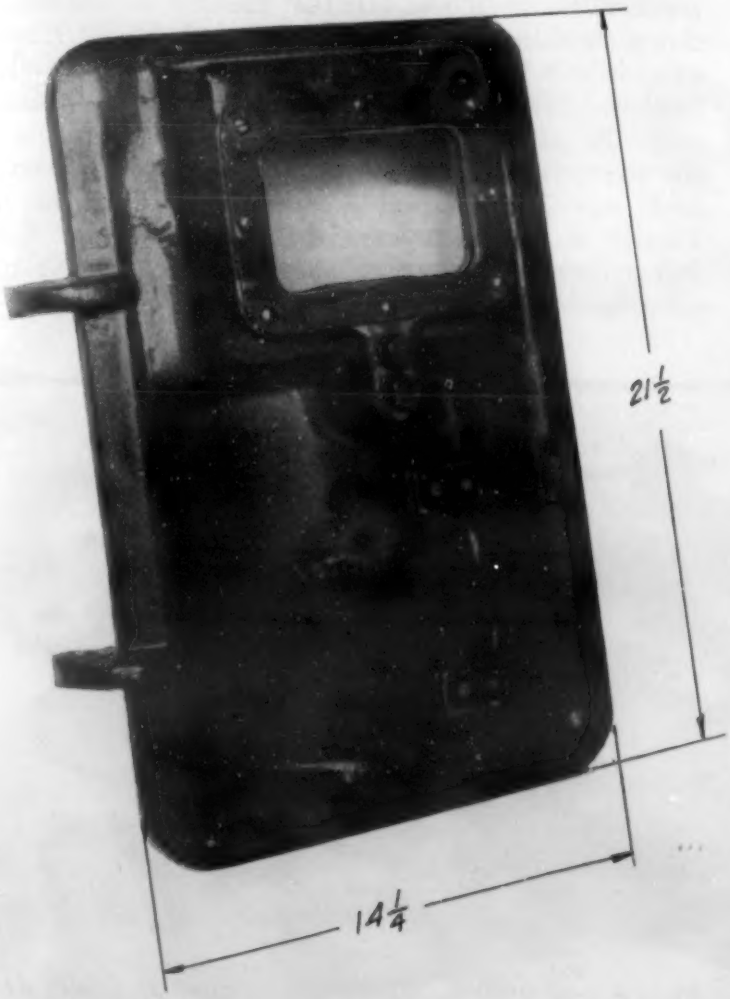
Substituting Welded Steel Sheet

When it became necessary to discard the use of aluminum, a redesign was made. In this design the window, (see Fig. 1) was dispensed with, it having been found that this window was of no essential value. The construction was simplified to include only one curved member, the main body of the door. This was made of 3/32 in. black sheet metal, rolled to the radius given, after which the two long edges were bent slightly outwards in a brake, to provide surfaces for welding to the frame. Stiffening members were tack-welded electrically inside the curved portion, and the two ends welded to the top and bottom, respectively, with continuous welds.

The frame was made of four machine steel strips, machined individually to the cross-section, and then arc-welded together to form a complete frame. This frame was drilled and tapped to hold retaining strips for a rubber seal, as illustrated by Fig. 3.

The previously welded, curved body was thereupon welded to the frame with a continuous weld all around, both on the outside and on the inside. The continuous outside weld served to cover up the drilled and tapped holes in the frame and to make the door vacuum tight. The inside continuous weld was added to eliminate any possibility of water or food products getting between the frame and the door body, thus starting corrosion or fermentation.

Fig. 1. The original vacuum door, made of cast aluminum alloys.



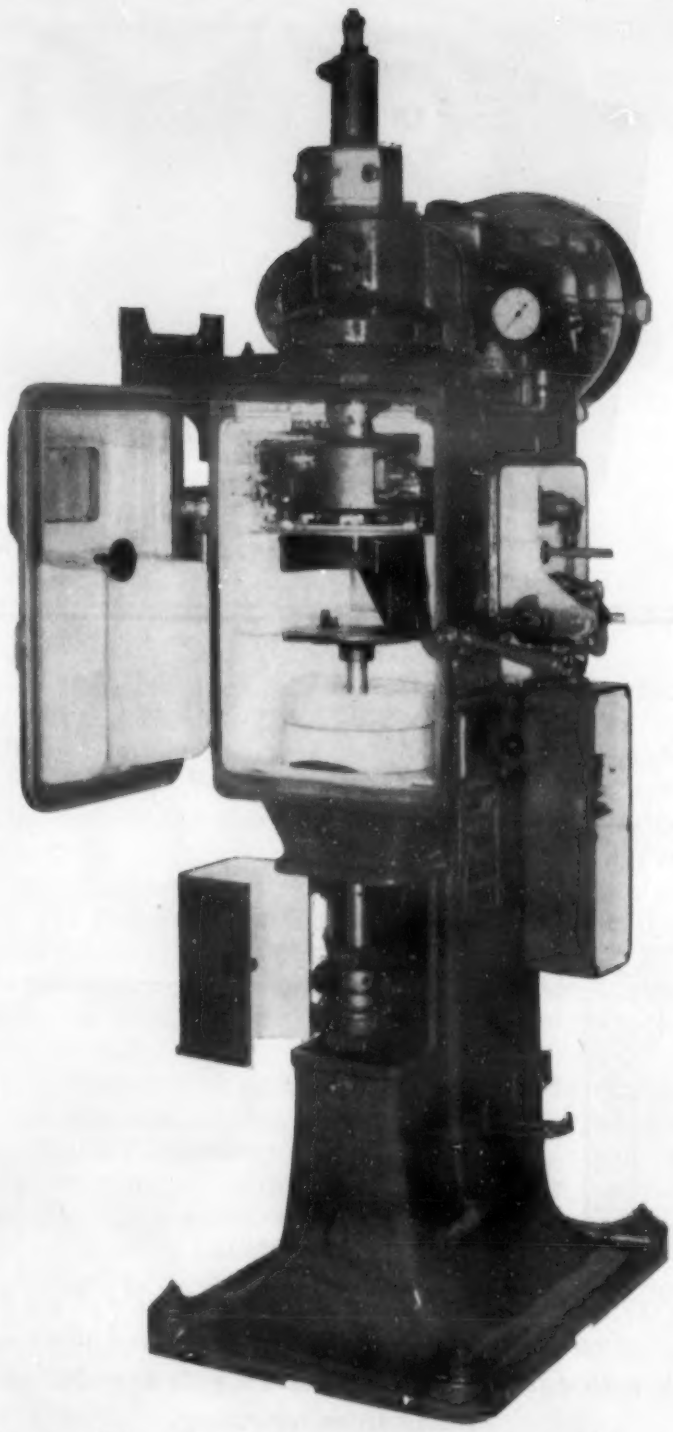


Fig. 2. The automatic vacuum closing machine in which the door (Fig. 1) is installed.

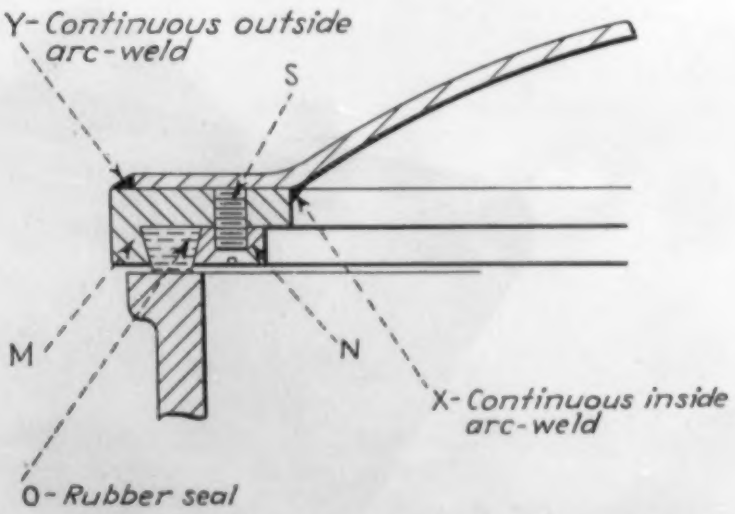
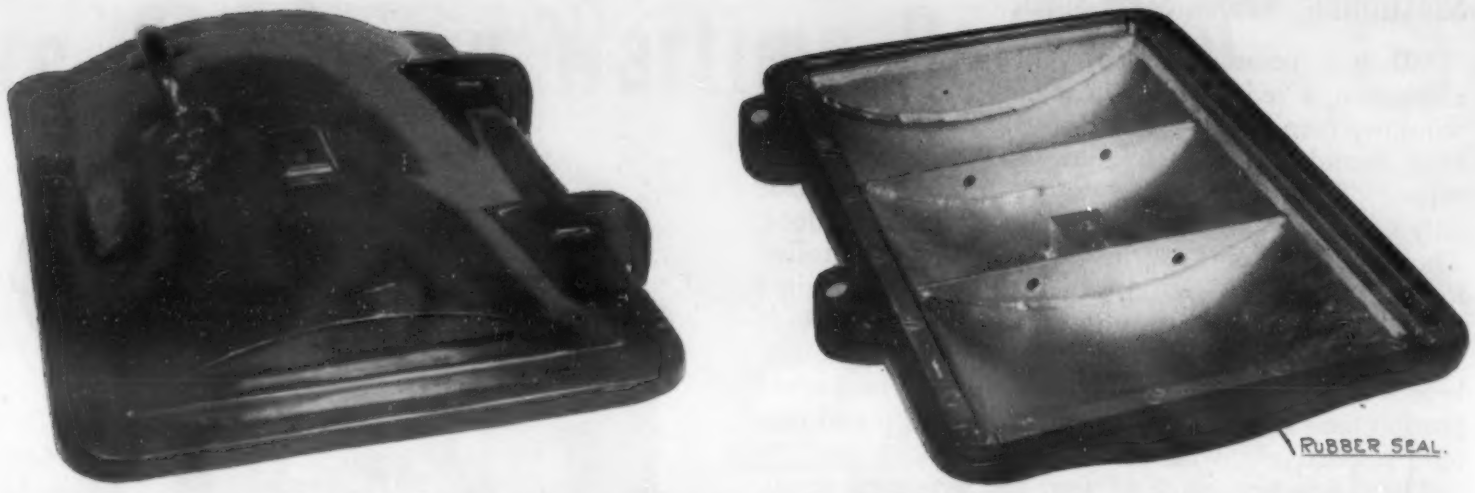


Fig. 3. The drilled and tapped frame for holding retaining strips for a rubber seal.



Figs. 4 and 5. Two views of a welded experimental door.

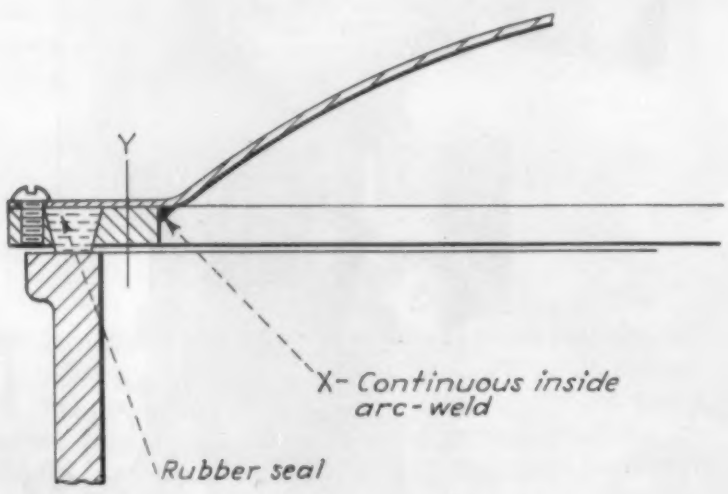


Fig. 7. One of the continuous welds in Fig. 3 is eliminated, it being only necessary to weld along line X with a few spot welds through Y to keep body and frame from separating.

After this the hinges and the handle were arc-welded onto the body to complete the door as shown in Figs. 4 and 5.

Only one door was made in this manner. It weighed 31 lbs., which was about 32 per cent more than the aluminum door. Its cost was about twice that of the aluminum door.

Thinner Sheet Successful

This, of course, was not much of an accomplishment, although it was felt that the cost would come down considerably with quantity production. However, it was decided to study the construction a little further. In the first place it was felt that the frame could be of lighter cross-section without impairing the strength. It was also possible to make the body itself of 1/16-in. sheet metal, instead of 3/32-in. Finally it was discovered that by "reversing" the frame construction, so to speak, it was possible to considerably reduce the welding time.

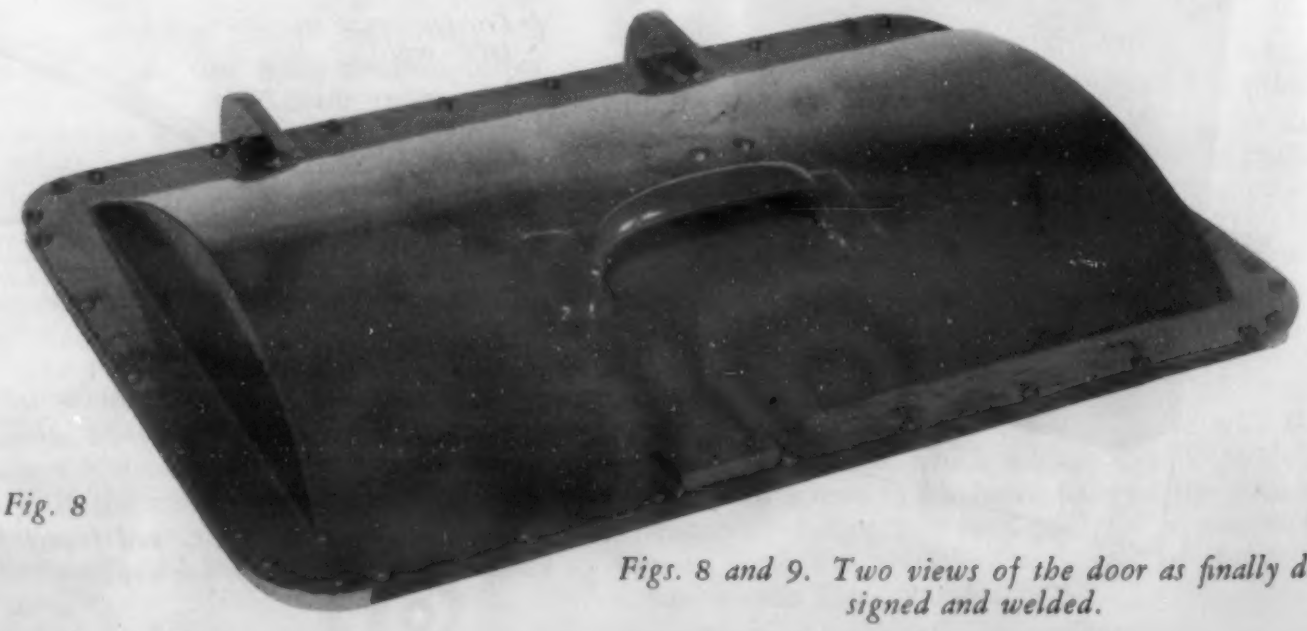


Fig. 8

Figs. 8 and 9. Two views of the door as finally designed and welded.

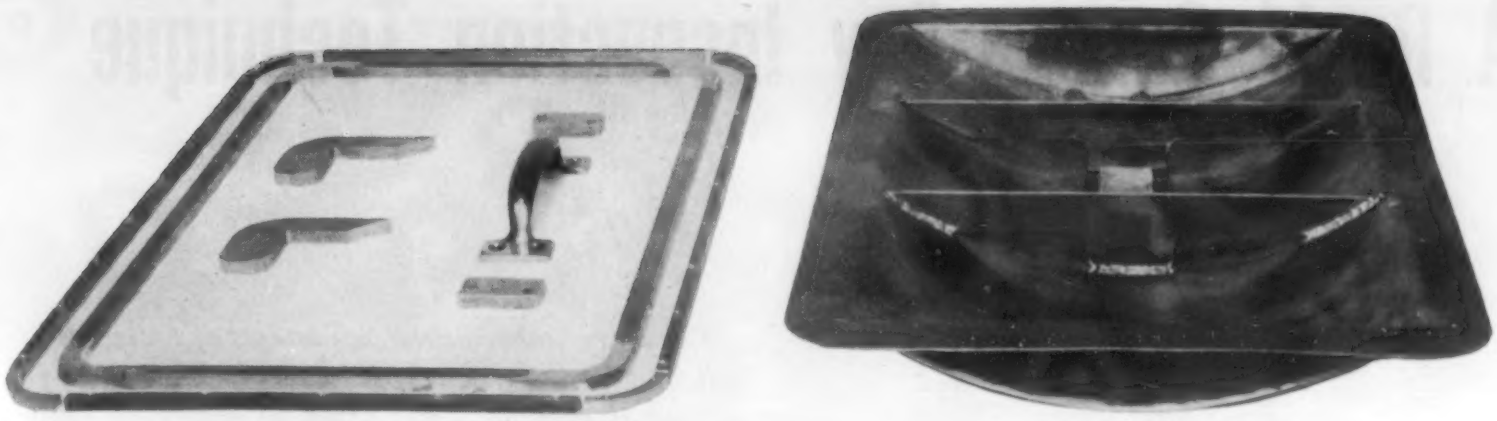


Fig. 6. Reversing the construction used in Figs. 3, 4 and 5, the inside frame is welded to the body of the door and the outside portion is screwed on after the rubber seal is in place.

The first frame, following the design of the original cast door, had been made as indicated by the cross-sectional Fig. 3. The outer portion of this frame, indicated by letter M, was welded to the body of the door; the inner portion, N, was screwed on after the rubber seal O had been inserted. As mentioned before, it was necessary, with this construction, to have a continuous weld on the inside, X, as well as on the outside, Y, to eliminate fermentation pockets at X and to keep it airtight at Y, the outside air otherwise being able to enter the vacuum chamber through the screw holes S.

In "reversing" this construction the *inside* frame is welded to the body of the door and the outside portion, consisting of previously machined strips, as shown in Fig. 6, is screwed on after the rubber seal is in place. It is readily seen that this eliminates one of the continuous welds, it being only necessary to weld along line X, Fig. 7, with a few spot welds through Y to keep body and frame from separating. The screw holes in this construction are in the outside strips, which places them outside the rubber seal. Thus there is no connection through these holes between the atmosphere and the vacuum chamber when the door is closed.

This latest construction of the door has brought the weight down to less than 14 lbs., compared with 22½ lbs. for the aluminum door. Even more satisfactory is the result in manufacturing cost. The aluminum doors used to be produced for something like $35 each. By eliminating the glass windows this could probably have been reduced to $25. The arc-welded door, of construction just described and as shown in Figs. 8 and 9 is now being manufactured for $20 each.

The total annual savings accruing from the change in manufacture, making these doors of arc-welded construction instead of cast aluminum, may not be very great in our plant, owing to the fact that can manufacturing machines have never been made in great quantities but the procedure described above is of interest because it shows what can be done when welding problems are approached in an engineering-like manner and it certainly points the way to more such accomplishments and even greater savings in the future.

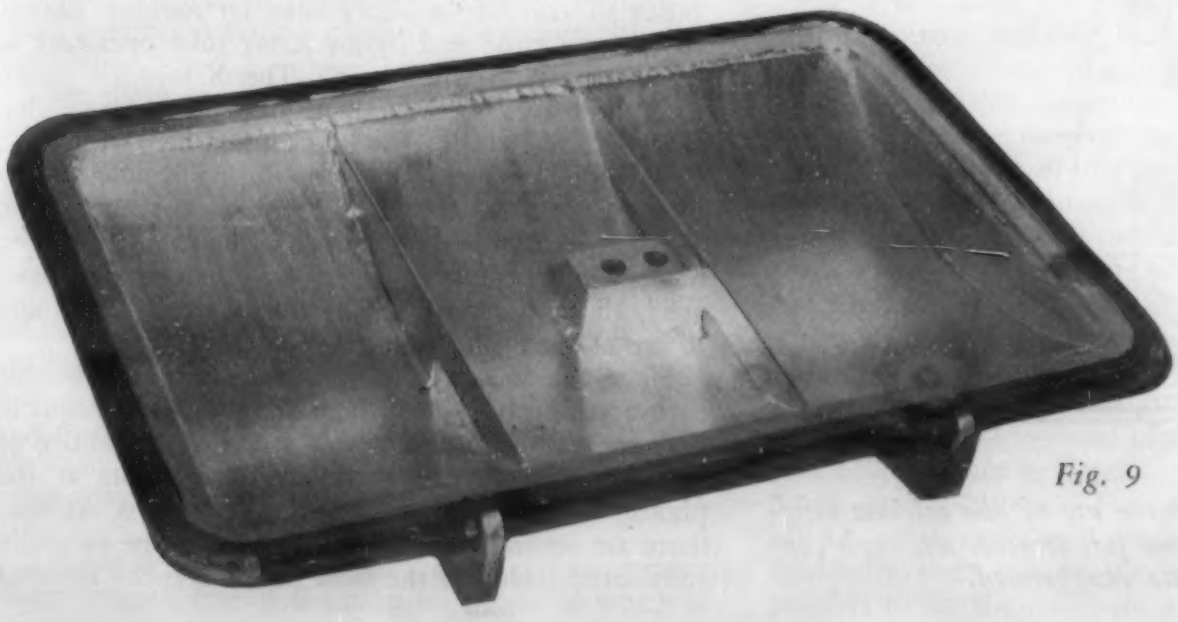


Fig. 9

A Rapid Gamma-Ray Inspection Technique

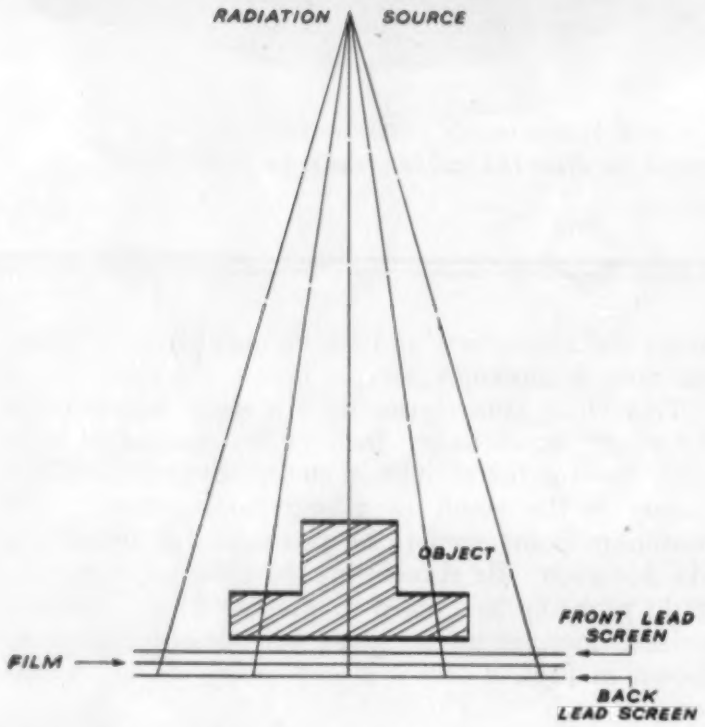


Fig. 1. The custom in gamma-ray examination has been to use lead foil on either side of the film and in direct contact with it.

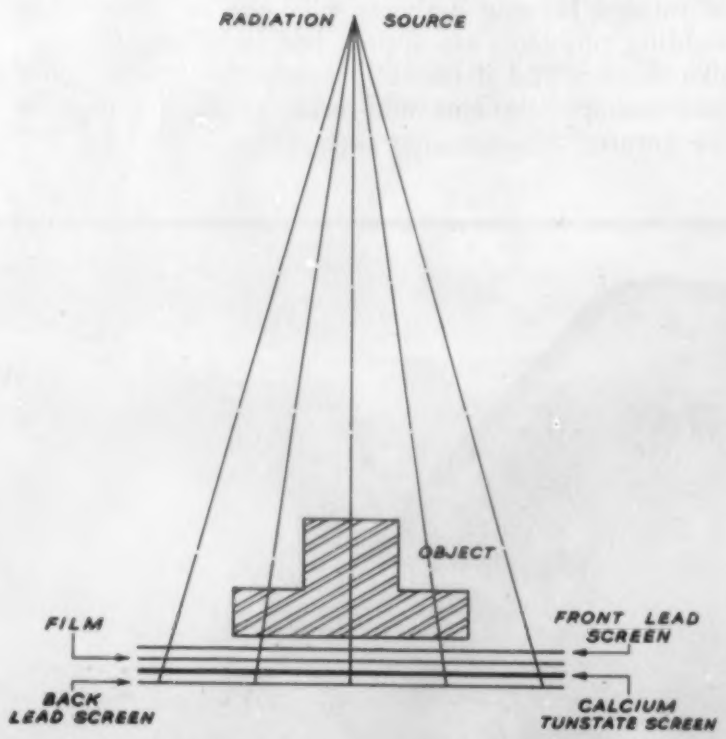


Fig. 2. This illustrates the use of one calcium tungstate screen and two lead foil screens, although conditions are exaggerated.

The many "convenience" advantages of radium for radiographic inspection would be even more widely enjoyed if exposure times could be reduced. This article describes a novel screen set-up that materially speeds the gamma-ray inspection process.

—The Editors

by ROBERT C. WOODS

Director of Research, The Taylor-Winfield Corp., Warren, Ohio

SOME METHOD WHICH WILL BRING gamma ray exposures down from days to hours, from hours to minutes, is certainly a problem worth working on. When considering the gamma ray as an industrial inspection tool, its principal drawback seems to be this question of exposure times. Assuredly radium has many admirable features, such as portability, compactness, small operating space requirements, lack of maintenance worries, and low rental costs. Furthermore, personal dangers attendant upon the handling of radium will become no danger at all when properly recognized and guarded against.

Decreasing Exposure Time

The matter of exposure times cannot be affected by any change at the source, because the radium emission of gamma rays is a process of nature over which man has no control whatever. Gamma rays are in reality X-rays of very short wave length. For purposes of comparison, they may be roughly likened to the rays produced by an X-ray tube operating in the one million volt range. The X-rays are generated, however, by the impact of high velocity electrons on a metal target, while gamma rays are ejected from within the radium atom during a spontaneous internal breakdown and subsequent rearrangement. Simultaneously emitted are also alpha rays—hydrogen nuclei—and beta rays—electrons—but these particles are both readily absorbed by matter of all kinds and so are of little interest to industry.

Since the source of radiation here is unaffectable by everything but the passage of time, all attempts to decrease exposure times with any given quantity of radium must be confined to improvements at the photographic film end of the set-up. To do this, there are several problems which should be carefully considered. One of the most pressing is the removal

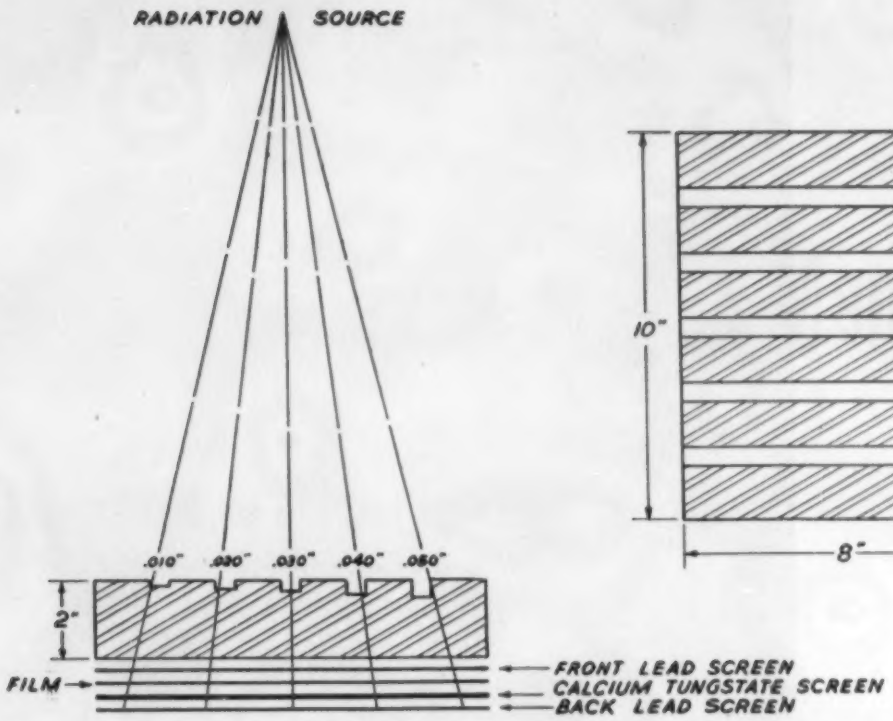


Fig. 3. This shows a gamma-ray test set-up.

of those scattered and secondary rays which detract from radiographic quality.

Parenthetically, it might be pointed out that the word radiograph is used here to denote not only an X-ray picture, but also that type of film sometimes referred to as a gammagraph or an exograph. Since all the actual effects producing pictures by X-rays and gamma rays are identical, radiograph then becomes a correct term for all of them. Use of other words seems to be largely a matter of momentary convenience.

The problem of scattered radiation, then, is present in all types of radiographic work, but with gamma rays it is especially pronounced due to the increased scatter at short wave lengths. It has, therefore, been the custom in gamma ray examination to use lead foil on either side of the film and in direct contact with it, as in Fig. 1. The benefits of this sandwiching effect are twofold; long wave length scattered rays are filtered out in the front foil, and secondly, both lead sheets emit photoelectrons when irradiated which produce a certain measure of radiographic intensification.

Now although the practice has rather gone out of favor for industrial X-ray work, clinical radiography makes extensive use of the calcium tungstate screen to decrease exposure times where it is required to "stop" the action of heart, lungs, or other moving organs. This technique takes advantage of the visible fluorescence emitted by the chemical calcium tungstate under the influence of X-rays. When two cardboard-like screens coated with powdered tungstate are substituted for the lead foil screens in Fig. 1, the fluorescence produced by them so increases the effect on the photographic emulsion that exposure times may be cut by a factor sometimes as high as 200.

Tungstate screens, however, have certain serious disadvantages, one of the most important of which is that they intensify the undesirable scattered rays as well as the radiographically desirable part of the beam. Since this scattered component merely places a blanket of fog over the film and does its best to obscure detail, it is evident it must be removed before any intensification is attempted.

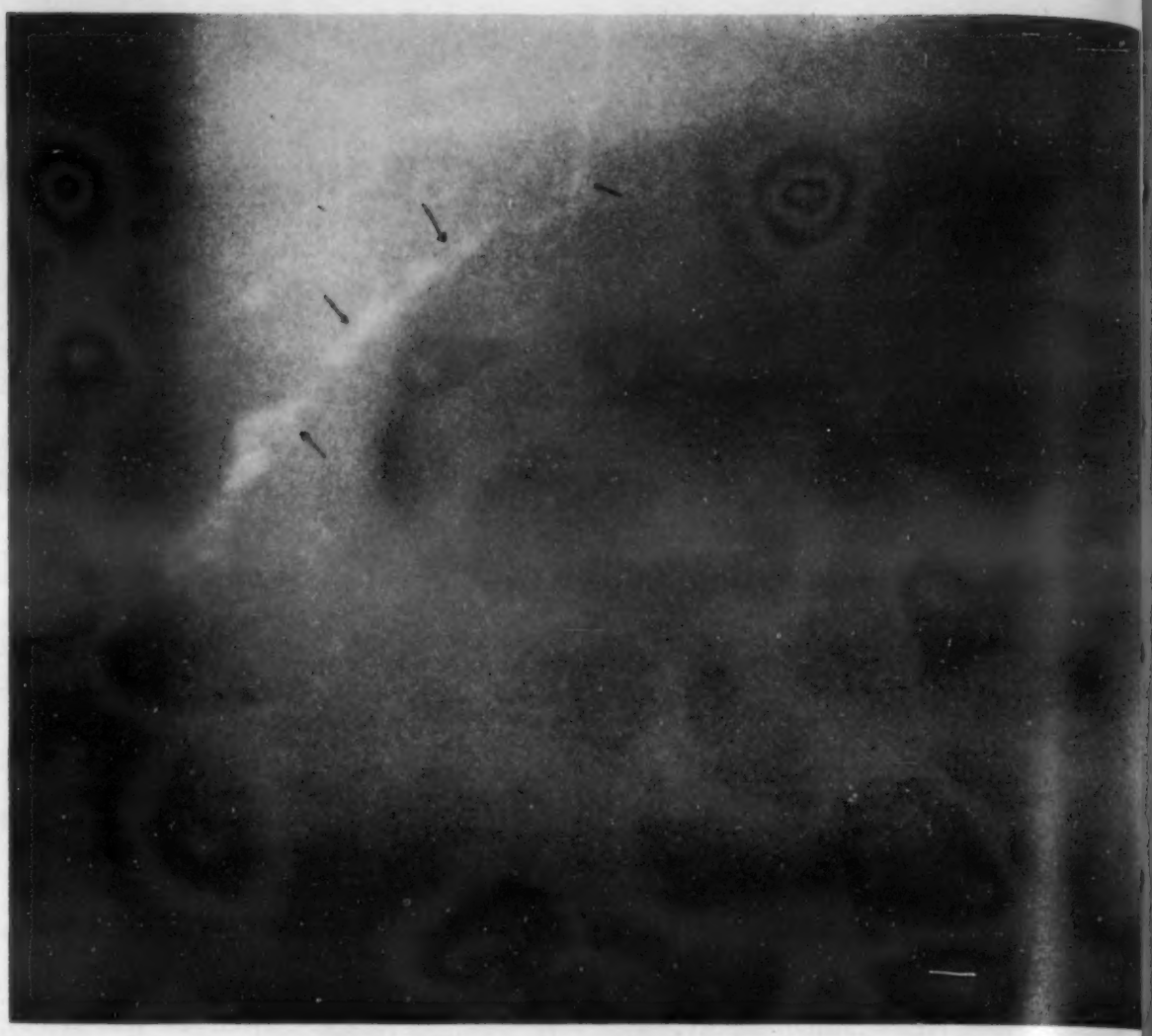
The New Method

Some years ago the writer published a technique (*The Iron Age*, Dec. 5, 1940) for use with 200 kilovolt X-ray work where the specimen thickness was such that exposures with lead screens alone became totally impractical. The aim of the technique is to utilize the best features of both lead and calcium tungstate screens in such a way that minimum loss of detail and sensitivity result. With some modification, this method apparently applies also to gamma ray inspection and saves hours in exposure times over those practices recommended by the majority of workers.

Fig. 2 illustrates the combination of one calcium tungstate screen and two lead foil screens, although conditions are of course exaggerated. As the radiation proceeds from the source, it passes first through the specimen, then through the front lead foil screen where a large part of the undesirable scatter is absorbed, and finally through the film to the calcium tungstate screen where it produces a fluorescent image, thus greatly intensifying the photographic effect. The rear lead foil screen plays no part in the intensification process, but is used to cut down backscatter from surrounding objects.

Fig. 3 shows a gamma ray test set-up consisting of an 8 x 10 x 2 in. steel block with grooves milled in the upper face to depths of 0.010, 0.020, 0.030, 0.040, and 0.050 in. Fig. 4 is a print of the resultant radiograph and while some detail has undoubtedly been lost in the reproduction, it is still possible to see the 0.020-in. groove which represents

Fig. 4. A print of one of the resultant radiographs.



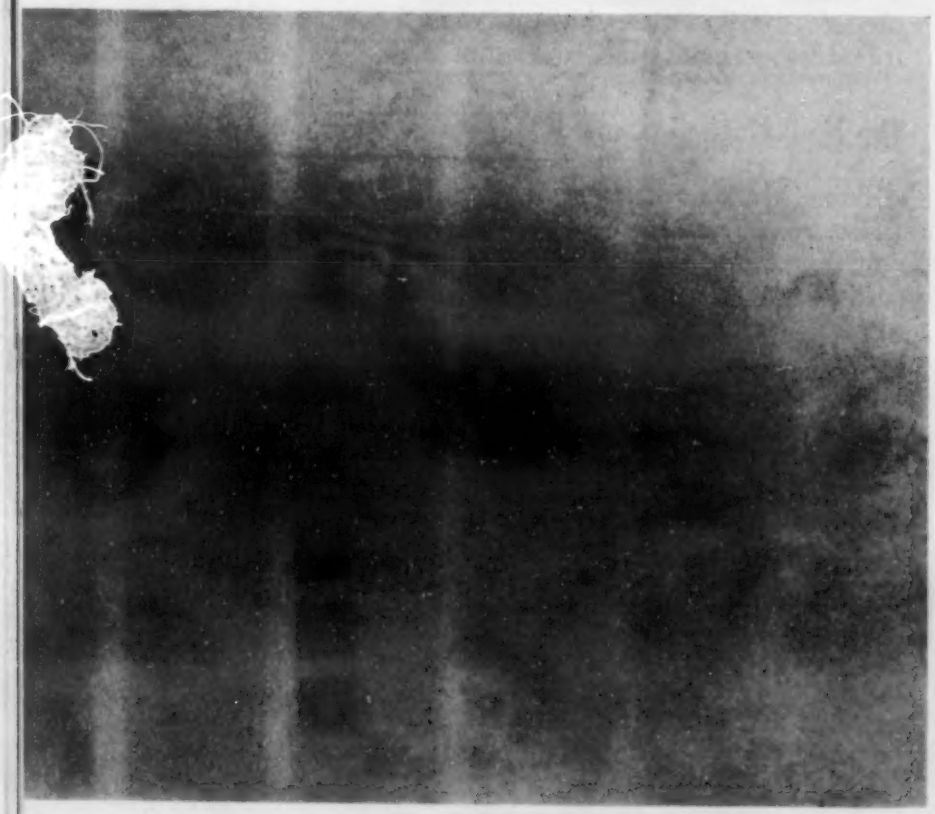


Fig. 5. A print of a radiograph of a 4-in. cast bearing section, demonstrating both a defective area and the Navy penetrameter clearly.

a thickness variation of 1 per cent. The 0.010-in. groove, a change of 0.5 per cent, is visible in the original film.

Fig. 5 is the print of a radiograph of a 4-in. cast bearing section demonstrating both a defective area and the Navy penetrameter clearly.

Films and Processing

Naturally, to attain highest efficiency with this technique, it is necessary to use a film whose properties make it particularly sensitive to the type of fluorescence emitted from calcium tungstate screens and most film manufacturers make available such emulsions. Admittedly, the use of two calcium tungstate screens would further speed up the work, but this is not advisable. In the first place it is best to have the front lead filter screen as close as possible to the film in order to minimize radiation spread before the image is made. Then too, double screens produce a much more grainy radiograph than does one screen. This is because a tungstate crystal is so relatively large that when it fluoresces, each one exposes a multitude of photographic emulsion grains, which also lends to indistinctness of outline and resolution.

With a front lead screen 0.005 in. thick, exposure times are reduced by about 85 per cent over customary techniques. While use of 0.010 in. lead foil somewhat increases the radiographic quality, it also lengthens the exposure time and the advantages have been found to be so negligible that the practice is not recommended.

In closing, it might be mentioned that the gain in contrast derived from the use of the single calcium tungstate screen is so marked that over-development in potassium iodide developer is not necessary. This is of considerable benefit where hundreds of X-ray films a day are being processed and the dark room technician must be advised every time gamma ray films are also handed in for development. In short, the gamma ray film now requires no special handling whatever.

Open-Hearth Slag Control for Manganese

by C. F. Quest, A. E. Martin, and T. L. Joseph

Department of Metallurgy, University of Minnesota, Minneapolis, Minn.

With the A.I.M.E. holding its annual Open-Hearth Conference this month, it is appropriate to have this report on open-hearth slag conditions that favor maximum retention of manganese in the melt—a most desirable aim in view of the need to save manganese wherever feasible. This article is part of Dr. Quest's Ph.D. thesis at the University of Minnesota.

—The Editors

THE CONSERVATION OF MANGANESE wherever possible is important in view of curtailed imports of ore. Under favorable conditions a portion of the manganese in the pig iron or in alloy additions to the open hearth furnace is retained in the steel. The proportion of the total manganese charged which is retained in the steel will be favored by high finishing temperatures and a high concentration of manganese oxide (MnO) in the slag relative to iron oxide (FeO). A high residual manganese, which decreases the amount of ferromanganese required to bring the manganese up to specifications, is also favored by an increase in the basicity of the slag up to a lime-silica ratio of between 2 and 2.4. Up to this basicity, the lime liberates the manganese oxide from complex silicates thus increasing its activity as a slag component.

Further additions of lime increase the slag volume, thus lowering the concentration of manganese oxide in the slag and the residual manganese in the metal. Moreover, more basic slags are likely to contain more iron oxide (FeO) which tends to lower the residual manganese.

Slag equilibria in the open-hearth furnace are therefore of great significance at present. Information on slag equilibria based on plant data has recently been presented by Darken and Larsen.[1] Information from laboratory tests which permit a closer control of temperature is presented in this paper.

Distribution of Manganese

The reaction that controls the distribution of manganese between slag and metal in the open-hearth is generally written as follows:

$$FeO_{(slag)} + Mn_{(metal)} = MnO_{(slag)} + Fe_{(metal)}$$

If it is assumed that activities of the various constituents are proportional to their molar concentrations and that the activity of iron is substantially unity, the equilibrium constant for this reaction can be written as

$$K' = \frac{(MnO)}{(FeO)\ [Mn]}$$

The usual nomenclature is followed. Brackets denote molar concentration in the metal phase and parentheses represent molar concentrations in the slag phase. If, as usual, it is further assumed that the weight per cent $[Mn]_w$, is directly proportional to the molar percentage of manganese, a similar but more convenient expression is obtained for the equilibrium constant

$$K_{Mn} = \frac{(MnO)}{(FeO)\ [Mn]_w}$$

Darken and Larsen collected a set of more than 100 analyses of slag and metal samples taken from open-hearth heats under favorable conditions with respect to measurement of temperature, simultaneous sampling of metal and slag, and slow working of heats in finishing stages. From Körber's[2] equation,

$$\log K_{Mn} = \frac{10710}{T} - 2.877$$

for the manganese constant as written above, the manganese content of the metal was calculated and

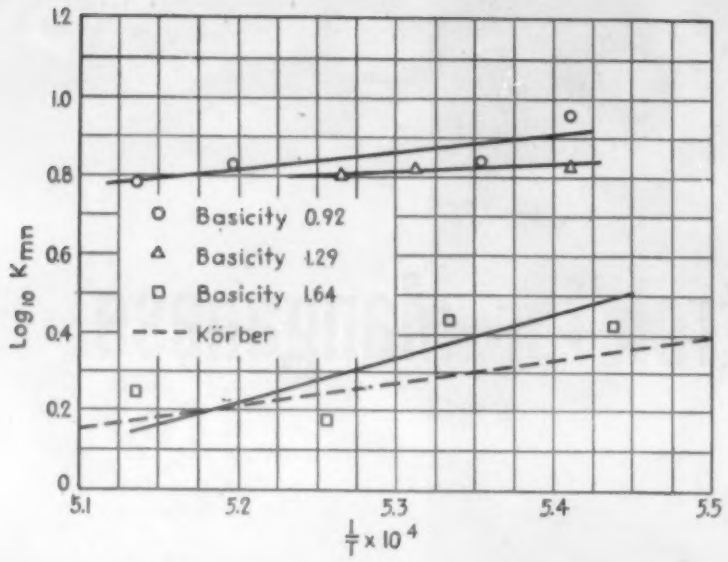


Fig. 1. Effect of temperature on manganese equilibrium constant.

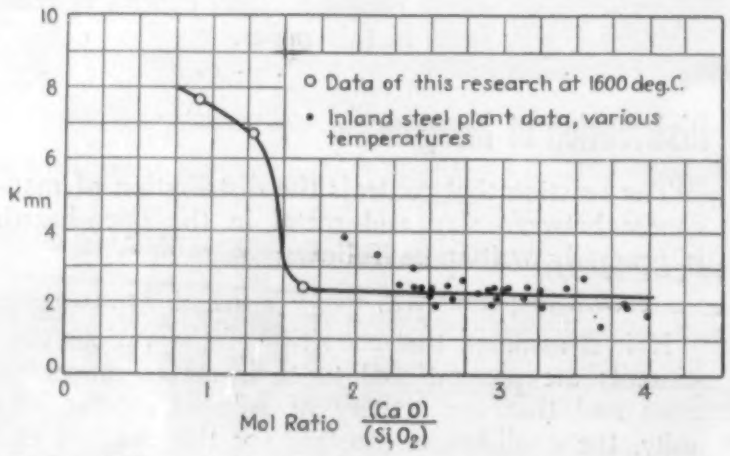


Fig. 2. Effect of slag basicity on manganese equilibrium constant.

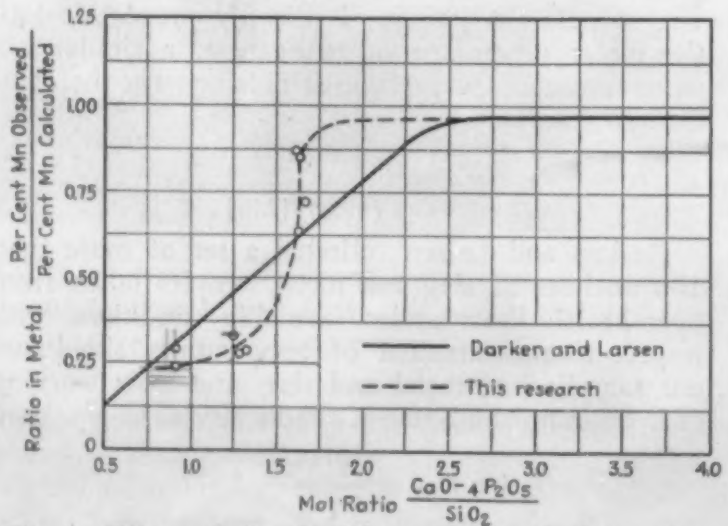


Fig. 3. Effect of slag basicity on ratio of observed to calculated residual manganese.

compared with the observed value. The ratios of the calculated to the observed values were plotted against the basicity of the slag.

Above a basicity of about 2.4, the ratios were found to be fairly constant and substantially equal to unity. This indicated that in this range of basicity, the concentration of manganese in the bath of the open hearth could be calculated satisfactorily from the equilibrium constant of the manganese reaction as written above. Below a basicity of 2.4, the ratio was found to decrease with decreasing basicity; the observed manganese was less than the calculated.

An interesting confirmation of the findings of Darken and Larsen is provided by laboratory experiments which were completed before their paper was presented. The rotating induction furnace described by Scott and Joseph[3], was used in these experiments. Three series of slags with lime silica molar ratios of 0.92, 1.29, and 1.64, were investigated at temperatures from 1565 to 1675 deg. C. (2850 to 3050 deg. F.). The slags were prepared from dry powdered silica and calcium oxide formed into briquettes. Magnetite was added to the extent of about 10 per cent, to facilitate melting. Experiments were attempted with more basic slags but the slags could not be melted. Fragments of open-hearth pancakes of high lime silica ratios were also tried. The slags melted readily but froze before equilibrium was established as a result of changes in composition accompanying the slag metal reactions.

Experimental Procedure

The metal bath used in the investigation consisted of open-hearth ingot iron alloyed with 0.025 to 0.050 per cent of electrolytic manganese. Experiments with baths up to 0.98 per cent Mn were also made and although similar results were obtained, they were not as consistent and are not included in this paper.

A 500-gram charge of ingot iron was placed in the furnace crucible and melted down. The alloying addition of manganese was then made, time being allowed for its assimilation. A 15-gram slag briquette was then added to the bath in the rotating crucible. The temperature was adjusted to that chosen for the experiment. After 1 hr. at this temperature, the slag was removed in a chilled condition by means of a special vacuum operated apparatus. The metal bath was killed with aluminum and then cooled, producing sound metal. The slag and metal were sampled and analyzed.

Interpreting the Results

From the results reproduced in the Table, the equilibrium constant K_{Mn} was calculated for each set of data. Values of log K_{Mn} were plotted versus the reciprocal of the absolute temperature for each of the three slag types, as shown in Fig. 1. Körber's equation is also represented in this figure. It can be observed that for the slags of basicity 1.64 there is a fair agreement with Körber's equation. The equilibrium constant for the slags of basicity 0.92 and 1.29, is much greater than Körber's K_{Mn}.

Table of Analyses of Slag and Metal Samples

No.	Temp. deg. F.	Metal, Per Cent Mn	Metal, Per Cent C	Slag analysis, per cent SiO_2	Al_2O_3	MnO	FeO	CaO	MgO	K_{Mn}	Basicity CaO/SiO_2	Calc. Mn, %
1 A	2867	0.026	0.056	48.49	0.48	1.62	6.84	42.18	0.36	9.23	0.932	0.108
1 B	2903	0.028	0.067	49.93	0.38	1.13	5.83	42.55	0.15	7.02	0.913	0.095
1 C	3006	0.029	0.034	49.76	0.42	1.15	5.87	42.57	0.20	6.85	0.915	0.120
1 D	3047	0.031	——	50.08	0.41	1.02	5.46	42.71	0.27	6.11	0.913	0.125
2 A	2867	0.032	0.054	44.19	0.39	0.56	2.63	51.59	0.56	6.80	1.250	0.097
2 B	2930	0.035	0.047	42.65	0.42	0.68	2.93	53.00	0.24	6.72	1.330	0.121
2 C	2966	0.029	0.032	43.25	0.26	0.50	2.72	52.73	0.07	6.43	1.293	0.103
3 A	2851	0.032	0.050	37.86	1.13	0.25	3.05	57.05	0.62	2.65	1.614	0.037
3 B	2916	0.031	0.065	37.26	1.25	0.24	2.84	57.95	0.36	2.76	1.667	0.043
3 C	2966	0.030	——	37.66	0.44	0.17	3.77	57.36	0.50	1.52	1.630	0.047
3 D	2047	0.050	0.056	38.17	0.39	0.21	2.39	58.47	0.22	1.78	1.639	0.059

Values of K_{Mn} at 1600 deg. C. (2912 deg. F.) were interpolated from Fig. 1 and then plotted versus the basicity in Fig. 2. Values of K_{Mn} calculated from some data collected at the Inland Steel Co. are also included but were given relatively little weight in drawing the curve as accurate temperature readings were not available for the plant data. Most of the scattering of these points can be attributed to temperature variations. Fig. 2 clearly shows that K_{Mn} is not a constant in the basicity ranges studied. The plant data indicate, however, that K_{Mn} is substantially constant at higher basicities.

The data were also treated by Darken and Larsen's method of presentation which has been described. By this method the results of each melt appear as a point on the curve. The resulting Fig. 3, is a plot of the ratio $\frac{\%\text{ Mn observed}}{\%\text{Mn calculated}}$ versus the basicity. Darken and Larsen's curve, with the experimental points omitted has been given in the same figure to facilitate comparison. It can be observed that there is a general agreement. However, the ratio for the laboratory data departs from unity at a lower basicity and much more sharply.

Conclusions

Data on the distribution of manganese between slag and metal were obtained from melts made in the laboratory with a rotating induction furnace. Data collected in this manner more accurately represent equilibrium conditions than data collected from practice. A general agreement has been observed, however, between these data and open-hearth data collected by Darken and Larsen. It is suggested that discrepancies may largely be explained by the closer approach to equilibrium conditions in the case of this research.

Although some doubt may exist as to the basicity at which the activity of MnO and FeO decrease in moving towards more acid slags it seems quite certain that a rather sharp break does occur.

References

(1) L. S. Darken and B. M. Larsen, "Distribution of Manganese and Sulphur Between Slag and Metal in the Open-Hearth Furnace." *Trans.* A.I.M.E. Vol. 150, 1942, pages 87-112.

(2) F. Körber, *Stahl und Eisen,* Vol. 56, 1936, page 433.

(3) F. W. Scott and T. L. Joseph, "A Rotating Induction Furnace"; METALS AND ALLOYS, Vol. 15, March 1942, pages 976-78.

A Letter to the Editor

Open-Hearth Steel Making

To the Editor: Please refer to the following statement from the article, "Open-Hearth Steel Making," by Leo Reinartz in January METALS AND ALLOYS, page 53: "Aluminum and ferromanganese have been conserved without resorting to other materials." This statement is true with respect to manganese, but is incomplete with respect to aluminum.

A considerable amount of steel that was formerly aluminum killed is now being killed with ferrosilicon; some shops are using silicon for the deoxidation of rimmed steel; and there has been conservation of aluminum by the use of rasorite as a ladle addition to rimmed steel.

Our own experience has been that use of substitute materials has enabled us entirely to eliminate bar aluminum consumption and to cut the total aluminum consumption by 90 per cent, that is, the monthly consumption of aluminum is now 10 per cent as much as it was before we made the change. We feel that this great a saving could not have been made without resorting to other materials.

Wheeling Steel Corp.
Steubenville, Ohio

F. G. NORRIS
Assistant Metallurgical Engineer

Mr. Reinartz Replies

I am in agreement with Frank Norris that my statement regarding ferro-manganese and silicon conservation was too narrow.

We have reduced the use of manganese directly. In case of aluminum we have also made substantial reduction in the use of this commodity by the substitution of silicon. For good rimming steel, however, we prefer to eliminate the use of all ferro-silicon.

L. F. REINARTZ

Design of Sand Castings

for Quantity Production —Part 1

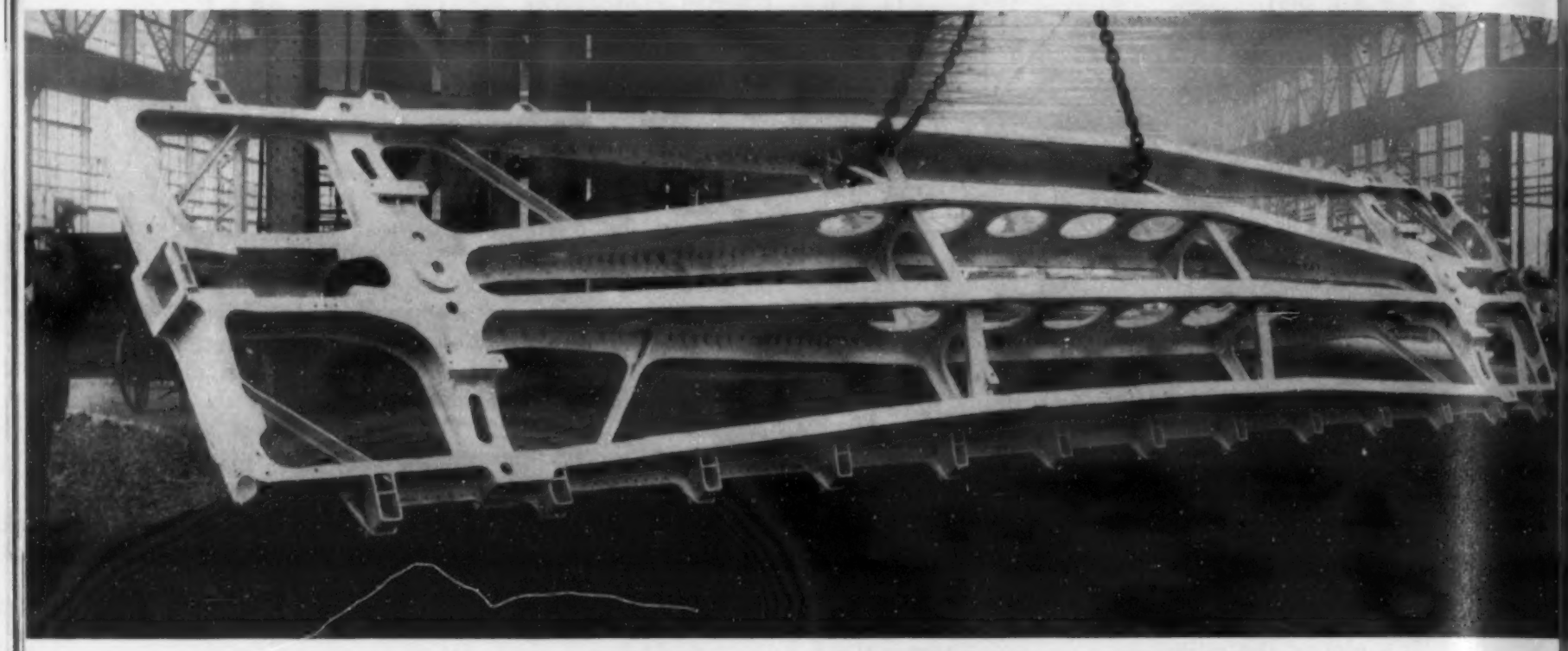


Fig. 1—One-piece, cast steel underframe for 70-ton flat-car 50 ft. long which is made as a "built-up" (assembled) core job. (Courtesy: Scientific Cast Products Corp.)

by N. F. HINDLE

Assistant Secretary, American Foundrymen's Assn., Chicago

Unfamiliarity with the technical limitations and possibilities of the sand casting process on the part of design engineers has been the traditional despair of foundrymen trying to get high yields of good-quality castings on production schedules. This article (which is to be a chapter in a forthcoming book edited by Herbert Chase on "Designing for Quantity Production") presents information on the "how" of sand casting that the designer — either in a foundry or outside — should know, and offers some detailed but generally applicable design rules peculiar to sand castings, in both ferrous and non-ferrous materials. It begins in this issue as a gesture of dedication to the annual convention this month of the American Foundrymen's Association. —The Editors

SAND CASTINGS are produced in quantities exceeding 20 million tons annually in the United States alone. Such castings promise to continue in still more extensive use, partly because: (a) they constitute a basic, low-cost necessity, (b) they lend themselves to highly economical production in large quantities and — among other reasons — (c) many ways of increasing their utility are being developed.

Crankshafts and camshafts for automotive engines, for example, are now being sand-cast in large quantities, whereas, hardly more than a decade ago, even the mention of a feasible cast crankshaft would have been received with scorn. Today, engineers can secure almost any set of properties desired in sand castings. Besides being available at moderate cost, sand castings can be produced in an almost unlimited variety of shapes and sizes (some designs being practically unproducible by other means) and with the metal favorably disposed in relation to the stresses applied. As no dies are required, tooling costs for small castings are often much lower than for somewhat similar products suitable for quantity production, although machining costs sometimes offset this advantage.

Production Sand Castings

Production castings cover a wide variety of sizes and designs. This makes it difficult to cover the subject of design in an all-inclusive manner. Most casting methods other than the sand process, such as centrifugal, permanent mold and die casting, are limited in application, in the number or nature of the

possible alloys that can be used and in the size or shape, or both, of the casting.

This is not true of the sand casting process, in which there is little restriction as to size or alloys from which castings can be made on a production basis. As a result, production sand castings may vary from several to the ounce to several tons. For example, thousands of valves of varying types, cast in a variety of metals, are made by the sand casting process annually. Many of them are molded on machines by the match-plate method.

On the other hand, relatively few engine and car frames, in comparison to valves, are made each year. Such railroad castings weigh from about 60 to 75 tons and yet are considered production jobs. They usually are made by what is termed pit molding and in foundry language are "built-up core jobs." Production of such castings requires a large number of core boxes and no pattern. Fig. 1 shows a one-piece 70-ton flat car underframe, 50 ft. long, made by that method.

Obviously, it is difficult to draw up design rules that would be applicable to such a wide range of product. The following suggestions may be used, however, as a guide in designing castings for production regardless of size.

Advantages of the Sand Casting Process

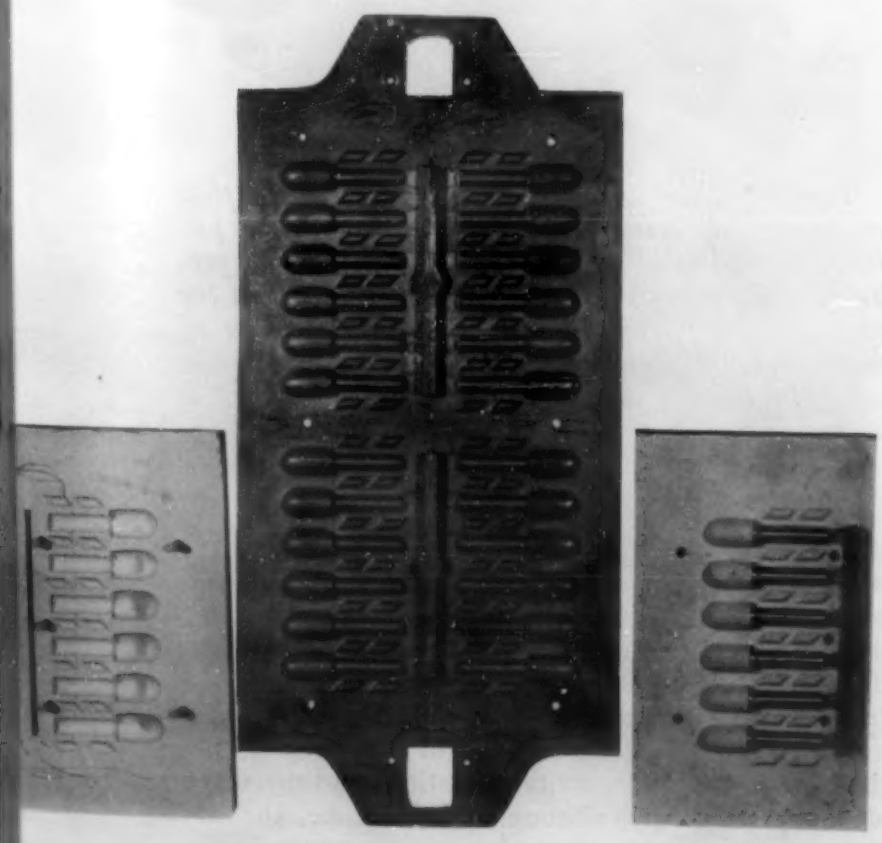
Sand castings are made by pouring liquid metals into sand molds. Either ferrous or non-ferrous metals can be used, and castings weighing from a fraction of an ounce to over 200 tons can be produced.

Sand casting lends itself to the formation of intricate as well as of simple integral parts, often with strength and rigidity not obtainable, at equal cost, by any other method of fabrication. In sand castings, the properties of the metal are practically the same in all directions. Metal can be so disposed that it will do the most good. The smooth, flowing lines possible in sand castings often have proved to be important sales advantages.

Proper design of sand castings often results in a saving in weight over other methods of fabrication. In other instances, castings have reduced machining time, number of operations and assembly costs.

Small parts that can be cast in sand molds can sometimes be cast into metal molds economically, but the reverse is also true. Many small castings, especially those having cores that could not be withdrawn if made of metal, can be sand cast readily but cannot be die cast. In addition, a large proportion of sand castings are too large to be cast in feasible metal molds and many alloys suitable for sand casting are not suitable for casting in metal molds. Although it is occasionally possible to duplicate the sand casting, as far as dimensions are concerned, by forging or by welding wrought metals, this can seldom be done at equal cost, if quantities required are considerable and, in many cases, the resulting product is less satisfactory, in certain respects, than the sand casting.

Fig. 2—Match-plate on which 24 duplicate patterns are mounted. With this equipment several thousand castings of this size can be made daily on one machine.



How Sand Castings are Made

As the design of the casting often affects the cost of one or more steps in the production process, and as the production operation imposes certain limits on design, the alert designer who wishes to keep costs down will thoroughly familiarize himself with production technique.

In sand casting, sand is, of course, the material used for both molds and cores. A pattern, commonly of wood or metal, is required to form the cavity into which molten metal is introduced. Variations in contour of cavities or recesses in the metal are produced by cores made largely from sand.

Molding Methods and Patterns. For high production of small to medium-sized castings, metal match-plates or metal cope and drag patterns are used. These are mounted on molding machines, the type of which depends upon the size and shape of the piece. A flask (a container for the molding material), the contour of which may depend on the shape but mostly on the size of the piece, is placed in position around the pattern, mounted on the platen of the machine, and is filled with sand having the correct physical properties for the type of casting being made.

The sand then is rammed, squeezed or jolted into position around the pattern in the flask to produce a mold of the proper hardness, permeability and strength. Sometimes a combination of jolting, squeezing and ramming operations is necessary to produce the proper type of mold. Following preparation of the mold, the pattern is withdrawn from the sand mold automatically or semi-automatically, depending on the type of machine used.

Most patterns for machine molding are designed with gates and risers attached. By machine molding, substantially precise duplicate molds are made by controlling carefully the properties of the sand and the amount of ramming. Usually, in production molding, where cope and drag patterns are used, two machines are operated, one to produce the top part of the mold or cope, and the other the bottom portion or drag. After both parts of the mold have been made, the cores, if any, are correctly placed, the mold is closed and clamped, and the assembled mold is ready for pouring.

Match-Plates

Metal Match-Plates are used to produce castings in large quantities. They are used generally for machine molding and consist of a plate on which the pattern is mounted and are so constructed as to be lifted either automatically or manually from the mold after it has been properly rammed, depending on the type of molding machine used. For small castings, such as those made on squeezer type molding machines, the patterns for both the cope and drag sections of the mold are mounted on the plate, on the top and bottom respectively, in the proper position, and the same match-plate is used for making both the cope and drag of the mold. The plate in all match-plates serves as the parting for the pattern. For larger castings, it is often more economical to use a pair of match-plates, one for the cope and one for the drag. Figs. 2, 3 and 4 show various types of match-plates.

The limiting factor in the use of match-plates is the size and weight of the mold. This in turn is limited by the handling equipment available in the particular foundry. Heavy squeezer molds, which must be handled manually, result in fatigue and production has been found to fall rapidly toward the end of the day when workmen tire.

Metal match-plate patterns for large quantities of small and medium-sized castings assure rapid and accurate reproduction. The initial cost of such equipment is greater than non-mounted patterns but the extra cost is more than justified by other savings when the total pattern cost is spread over a large quantity of castings.

The number of castings in an order which justifies the use of match-plates varies, depending to some extent upon local conditions and the equipment in the foundry doing the job. Standard time studies have shown that lower costs can be secured from match-plates rather than loose patterns when the order is for only 50 castings. Cases are known where match-plate equipment has been used with economy on orders for as few as 10 castings.

Metal match-plates are most adaptable to those castings which have a straight (single-plane) parting and can be made on molding machines of the squeezer type, but straight parting is not necessarily a limiting factor. When the number of castings desired is extremely large and it is impossible for the engineer to design a casting with a straight parting, a match plate having an irregular parting can be used, but this involves the design and use of special flask equipment and special set-ups on molding machines, which result in additional costs. In such instances, it should be determined whether or not the job will justify the cost of the extra equipment.

Another point to remember is that, in match-plate molding, the patterns are drawn upward vertically. There is no opportunity for twisting a pattern to withdraw it from the mold. Designs that do not facilitate a straight draw thus cannot be mounted on match-plates unless cores are provided to form the sections that cannot be drawn vertically.

Castings having surfaces so disposed that patterns can be drawn vertically are generally lowest in cost because they can be produced by machine molding methods, which is the most rapid method of mold production. It is difficult to prescribe rules for the design of castings to be machine-molded (other than those of a general nature as presented herein) because the process is so versatile. The only limitations to machine molding are the size of the molding machine available, the quantity of castings and the shape of the parting line, although of the three, the last

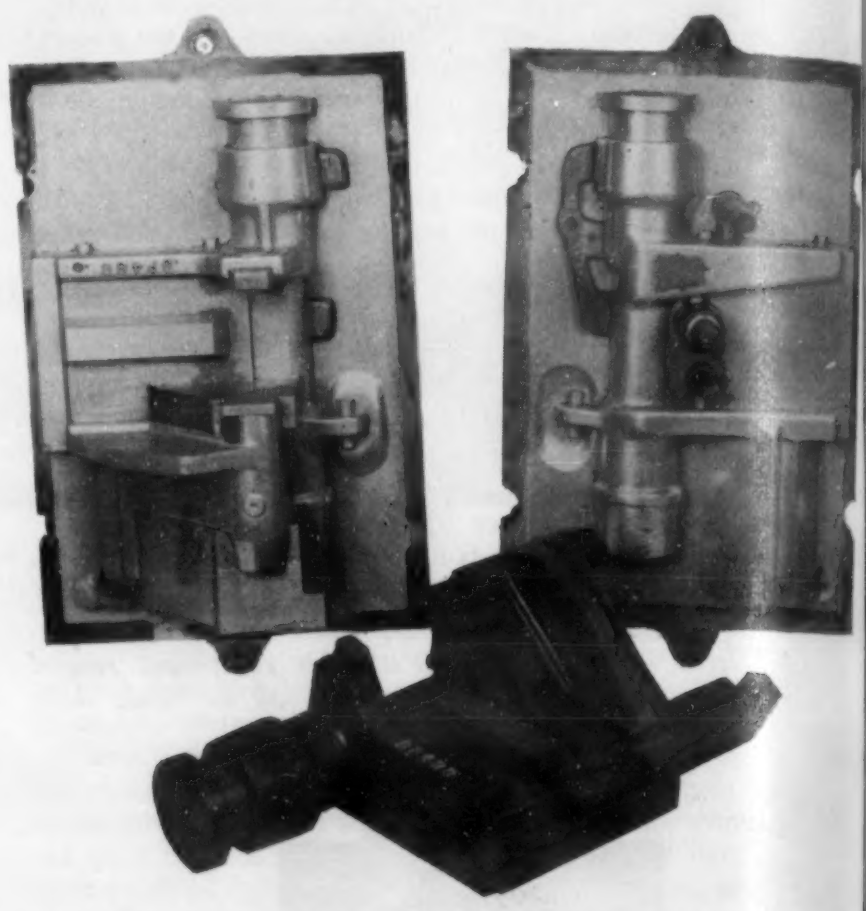


Fig. 3—Cope and drag views of a match-plate in process of manufacture on which a single pattern is mounted. The number of castings produced daily from the finished plate depends on the speed of the molding machine and the number of machines and duplicate patterns operated on the job. In Figs. 2 and 3, the gating arrangement is a permanent part of the equipment. (Courtesy: Scientific Cast Products Corp.)

is of least importance if the quantity of castings is large.

Cope and Drag Patterns are used for castings of considerable size. The size of castings which can be made, however, is limited only by the size of the molding machines, flasks available and the flask handling equipment in the shop. This type of pattern equipment is used for machine molding of what are termed "medium" sized castings.

Machine molding is not the only type used to make production castings, however. Floor and pit molding are used for large castings made on a production basis, such as the engine frames previously mentioned. In such instances, the mold may comprise several parts in addition to the cope and drag. All parts are assembled, the cores set, and the mold closed and clamped before pouring.

Melting, Pouring and Finishing

Melting Equipment. Metal used in the sand casting process may be produced in a cupola, electric, open-hearth, reverberatory, converter, crucible, pot, or air furnace. By far the largest tonnage of cast iron is produced in the cupola, although significant tonnages are produced in the electric and air furnaces. The latter type furnace melts the majority of the white iron from which malleable iron castings are made.

Certain non-ferrous alloys are melted in the cupola but the majority are melted in crucibles, pots and electric furnaces. Large tonnages also are melted in the open-flame and reverberatory furnaces.

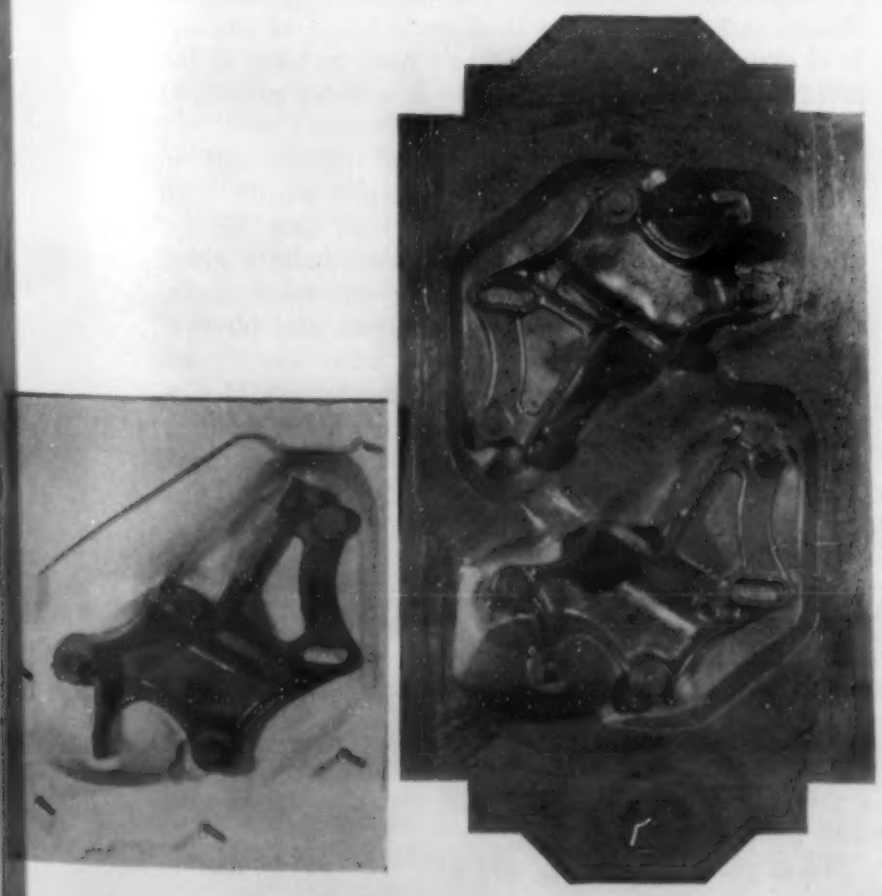
Steel for castings usually is melted in either direct-arc electric or open-hearth furnaces although high alloy steels sometimes are produced in the induction furnace. In some instances, the metal is melted in one furnace and heated to the proper temperature in another. This is called duplexing. Triplexing involves the use of three different furnaces, as, for example, cupola, converter and electric furnaces.

Pouring. When metal of proper chemical composition is melted and heated to the proper temperature, it is withdrawn from the furnace, by tapping, in some types, and, in others, by removing the container, and either pouring the metal directly into molds or into ladles and thence into molds.

Cleaning and Inspection. After pouring is completed and the metal has solidified and cooled sufficiently in the mold, the casting is shaken from the mold, the gates and risers are removed and the casting is cleaned by such processes as abrasive blasting, tumbling, or the like.

The casting is inspected at various steps in the cleaning process and finally just before shipment. In well managed and properly equipped foundries, all steps in the process are carefully planned and controlled to insure the best product possible.

Fig. 4—An unfinished match-plate on which the gating arrangement is not yet mounted nor the holes for the flask pins cut. This illustration is shown to demonstrate how an uneven parting line is feasible in some instances and still permits the use of match-plate equipment without the necessity of special flasks and machine set-ups. (Courtesy: Scientific Cast Products Corp.)



Various Casting Materials

Cast Iron. One of the first decisions the designer must make concerns the choice of the metal or alloy to be cast. Use of such general terms as "cast iron" or "steel" is too indefinite. There are uncounted types of cast iron. The American Society for Testing Materials (A.S.T.M. Specifications A48-41), lists seven classes of cast iron based on strength alone. Some properties of cast irons are shown in the Table that appears as "Engineering File Facts" No. 7, on page 780 of this issue. There are many classes of cast irons other than the seven there mentioned. In some, strength exceeds that in the highest classification by as much as 20,000 lbs. per sq. in. Others are especially designed metallurgically for heat resistance, corrosion resistance, wear resistance, machinability, hardness, and other properties.

Steel. There are also many types of steel for castings and over 70 known alloy steels are produced in the foundry industry today with tensile strength varying from 40,000 to 250,000 lbs. per sq. in. and elongations from 0 to 75 per cent. Noteworthy improvements have been made in properties of "straight carbon" cast steels through improved control of all operations, melting, heat treating and molding. The compositions and properties of some cast carbon steels are given on pages 90, 91 and 92 of "Cast Metals Handbook" (Amer. Foundrymen's Assoc., 1940), with similar information for some low alloy steels on pages 112 and 113 of the same volume.

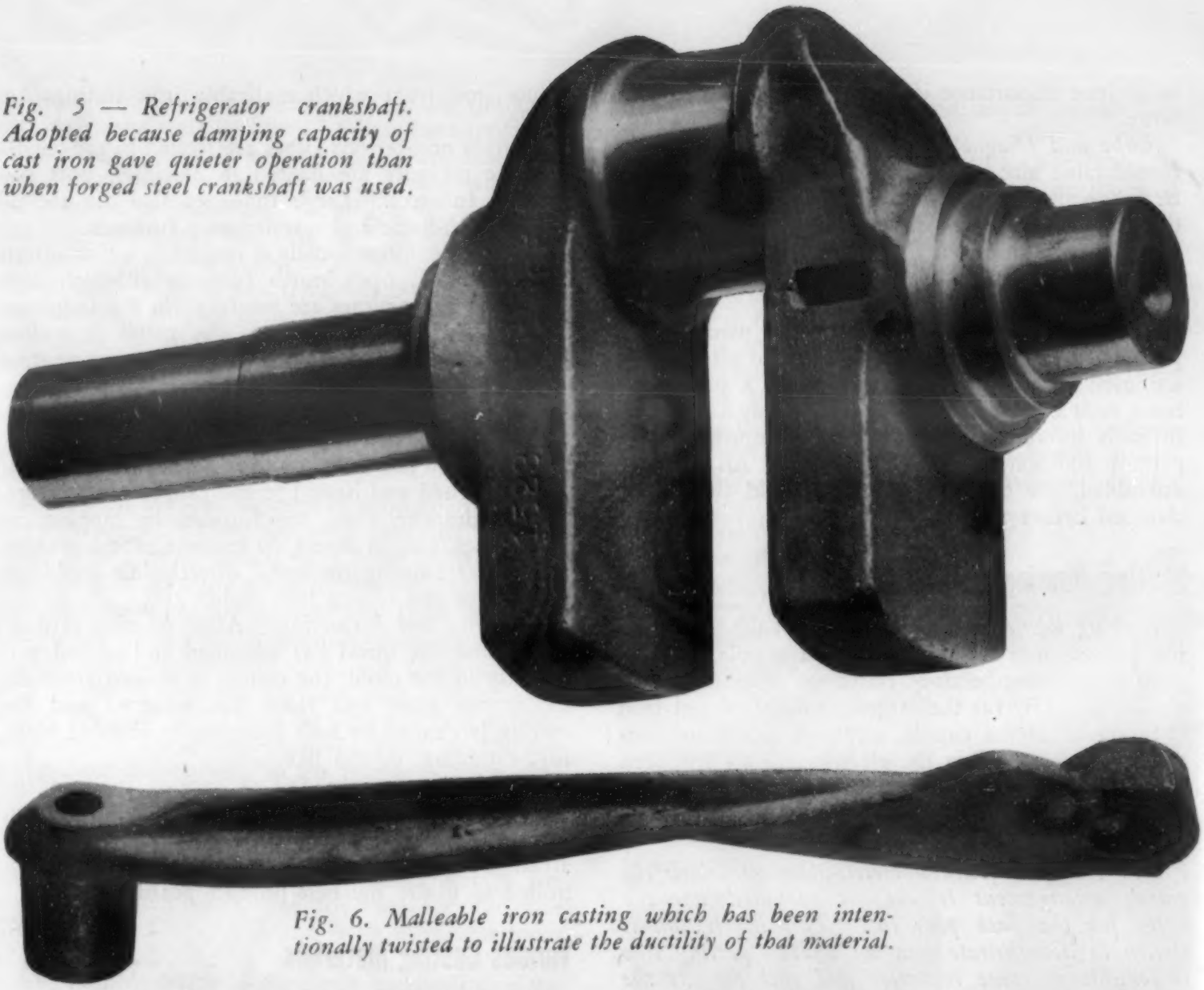


Fig. 5 — Refrigerator crankshaft. Adopted because damping capacity of cast iron gave quieter operation than when forged steel crankshaft was used.

Fig. 6. Malleable iron casting which has been intentionally twisted to illustrate the ductility of that material.

Malleable Iron is no longer merely that, either. In addition to the "regular" malleable irons, produced under A.S.T.M. Specifications A47-33, Grades 35018 and 32510, short cycle and pearlitic malleable irons are available. These are "tailor-made" malleables and have special properties for use in many engineering applications. Detailed data on the properties of regular malleable irons are given on page 222 of "Cast Metals Handbook." The range of properties of some more or less "standard" pearlitic malleable irons is from 60,000 to 75,000 lbs. per sq. in. tensile, 43,000 to 60,000 yield strength and 10 to 5 per cent elongation in 2 in.

Non-Ferrous. With the application of heat-treatment, aging and precipitation hardening of aluminum and magnesium alloys and some of the brasses and bronzes, the fields for non-ferrous castings have been considerably widened. The properties of many of these alloys can be varied to suit the engineer's requirements. A table to accompany a subsequent instalment of this article will give the normal compositions and properties of various classes of non-ferrous alloys.

Specifications. When a cast metal is specified, the general type of alloy, such as steel, malleable iron, cast iron, brass, bronze, aluminum, magnesium, lead, tin, nickel-base, etc., should be named but *the composition should not be specified,* as many foundries may produce a material of a general type which will meet strength and other requirements by several different methods or by several different compositions and treatments. The engineer or designer desires certain properties in a given shape of casting. It is not of particular interest to him, so long as the piece meets service requirements, how those properties are obtained.

Because of the large variety of metals cast in foundries, the large number of types within each class, and the many treatments which may be applied to the casting to produce intentionally a given set of properties after the casting has been made, any compilation giving typical analyses and physical properties is merely indicative of what can be accomplished under particular sets of conditions. Hence, *the tabular data referred to here are for guidance only and should not be used in specifying material.*

How to Select the Material

Space limitations preclude an extended discussion of the various types and classes of cast alloys. In general, it may be stated that the most economical material is the one which gives satisfactory service at lowest unit cost. Again in general, material costs for the production of non-ferrous castings constitute a greater proportion of the total cost than is the case with iron and steel casting.

To cite a given casting and give the cost of manu-

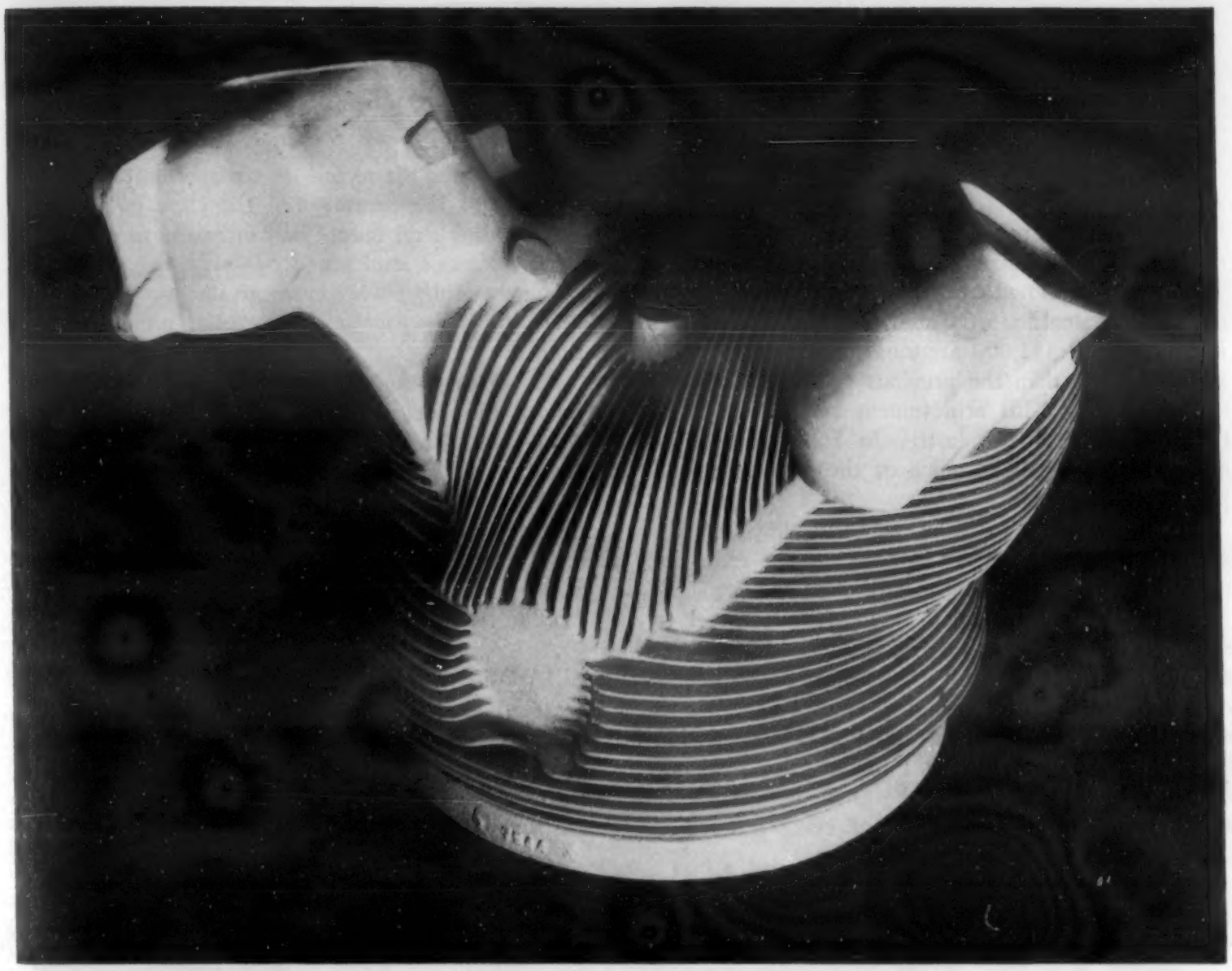


Fig. 7—Aluminum cylinder head casting with thin cooling fins. (Courtesy: Aluminum Co. of America)

facture in a variety of metals means little as it is the ultimate cost of the part, which takes into consideration its service life, that is of real significance. A part cast in one material may cost initially much less than if cast in another metal, but if the service rendered is greater in proportion to cost for the second metal, the ultimate cost of the part, when service life and maintenance are considered, may be much lower for the casting that costs more initially.

General Classification. In general, the various cast metals may be classified as to their relative merits in service as follows: *Steel* is known for its ductility, rigidity and impact resistance. The casting in Fig. 1 requires these properties in service. Certain types exhibit excellent corrosion resistance and resistance to heat at high temperatures and pressures. *Cast iron* possesses excellent machinability, good corrosion resistance, high compressive strength in relation to tensile strength, high vibration damping capacity, and excellent non-seizing, non-galling characteristics. Cast iron was adopted for the refrigerator crankshaft, Fig. 5, because of economy and the vibration damping capacity of that material. *Malleable iron* is the most easily machinable among alloys of equal strength and has good ductility. It also is an excellent material for resisting certain types of corrosion. Fig. 6 indicates the ductility of malleable iron.

Brass and bronze are primarily corrosion resistant alloys, are made in various colors for architectural and color-matching purposes, are well suited for plating (although other alloys are also), and include excellent bearing alloys. Some of the bronzes, such as the aluminum and manganese bronzes, approach steel in strength. They also are, in the main, easily machinable.

Aluminum and *magnesium* alloys are the so-called "light alloys." They are used primarily in applications where light weight is desirable or necessary. Aluminum castings possess good corrosion resistance under ordinary atmospheric exposures. Aluminum is also resistant to many chemicals. Aluminum alloys machine readily and certain of them take and hold a high polish without plating. A variety of colored finishes are produced thereon by chemical treatment. Magnesium alloys are one-third lighter in weight than aluminum alloys, are very easy to machine but, in general, are low in corrosion resistance unless given a chemical treatment. Fig. 7 shows an aluminum cylinder head with thin fins.

(To be continued)

(Editorials continued from page 751)

Our Alloy Steel Industry

In these columns we recently called attention to some record outputs for 1942 by the American steel industry—in particular to the phenomenal activity of the electric steel industry (February, page 344).

Now comes the announcement of the achievement of the alloy steel industry last year. A record-breaking total of 11,351,000 net tons was produced or 40 per cent more than the previous peak of 8,206,000 tons in 1941. This achievement virtually parallels that of the electric industry—in fact the two are closely related since so much of the alloy steel output is electric steel.

In calling attention to the record in alloy steel the American Iron and Steel Institute makes some interesting observations: In the early days of alloy steel, 1910 to 1913, only about 1 ton of alloy steel to every 50 tons of total steel was produced. By 1918, due to the first World War, output had expanded nearly 3-fold so that about one out of every 25 tons of steel produced was alloy. By 1929 the expansion had continued so that about 1 ton of alloy steel out of every 14 tons of total steel was made. Last year about 1 ton of alloy steel out of every 8 tons of total steel was the record—a remarkable progression.

What of the future? At the close of 1942 the rate of alloy steel output had increased to one out of every 6 tons of steel produced—with the prospect of this expanding to an even greater proportion this year. There is therefore substantial ground for optimism.

The capacity of the electric steel industry as of Jan. 1, this year, was nearly 4,555,000 net tons per year—an expansion of more than 140 per cent in the past 3 years—and still expanding. The character of the new N.E. and other steels is such that, even if the situation in the supplies of the strategic alloying metals continues, the use of such metals can be made to go farther. Then, too, some of the simpler steels can be made in open-hearth furnaces.

As long as the war lasts the alloy steel production will continue to expand and be large. Even when peace comes the new steels will insure a wider use by engineers.

We doubt if the public at large fully realizes the signal achievement which has been accomplished in this branch of the steel industry. —E. F. C.

LETTERS TO THE EDITOR

The Poor Goldbeater!

To the Editor: Tears poured down my face as I read (in METALS AND ALLOYS for July, 1942) the sad tale of the poor goldbeater, whose product price has increased a mere 13 per cent, while gold had increased 80 per cent in value. I was about to write a check to the order of the Society for the Benefit of Browbeaten Beaters, when I chanced to compute the value of gold in these eleven-dollar books of leaves. An ounce of gold makes 100 sq. ft. of gold leaf, which is sold in packages of 500 leaves, each measuring about 3¼ in. sq. Each ounce, therefore, makes 13,610 leaves, or 27.25 packages—unless I have misplaced the decimal point. At $20.67 per ounce, the value of gold was therefore $0.758 per package. This was sold for $9.80, and the balance, $9.04, was none too much for labor and overhead. Now gold has increased to $35 per ounce, or $1.284 per package of leaves. By selling this for $11.00, the beater receives $9.72 for his labor, or 7.6 per cent more than before. Let him praise the New Deal and Buy War Bonds.

ABACUS

Technological Censorship

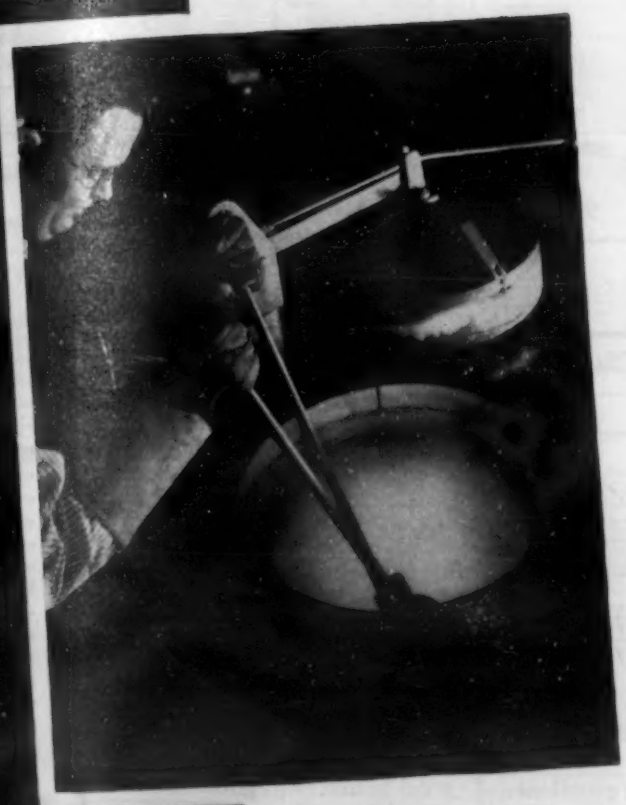
To the Editor: May I please add ditto to the protest on technological censorship. ["Some Censorship Protested," METALS AND ALLOYS, November, 1942, page 902.] Our industrial strategy is predicated basically on the great availability of certain raw materials, such as iron and petroleum on one hand, and our great wealth and American ingenuity on the other. The majority of us, if not in new positions, are at least learning new jobs and to make new products, which makes the question of censorship vital indeed.

Most everyone who has come in contact with this question dismisses it with the obvious thought that we do not wish to pass vital information to the enemy, and little or no consideration is given to the fact that some information which might be interesting, even useful, to the enemy is quite vital to our own industrial offensive. It is to be hoped that those responsible may be persuaded to evaluate information on the basis of whom it will benefit the most, rather than if it might conceivably by some remote stretch of the imagination help the enemy a little bit.

CRESTHEIM ROAD
PHILADELPHIA.

—W. B. BROOKS

TO MEET THE GRIM NECESSITIES OF WAR



IT is to help *you* speed the war effort that the lights are burning late in our steel production and research laboratories. More than 1200 metallurgists and trained technicians are working here. Their most important job today is to adapt steels to the rigorous demands of war economy and war-time manufacture. They are on our payroll but they are working for you.

Largely from their knowledge and experience were born the National Emergency Steels that have made it possible to meet the critical conditions imposed by the shortages of nickel, chromium, molybdenum, vanadium and other strategic alloys. They have written new recipes for lean-alloy steels that provide the required qualities without excessive use of alloying elements. They've proved that you can substitute one alloy for another to achieve satisfactory results. They've made thousands of experiments that show not merely what these steels will do, but how you, who must use these steels, can fabricate and heat treat them to give the best results in service.

The mass of new technical knowledge these men have turned up is vitally important to you. We gladly place it at your disposal. Properly used it can be of real help in applying the steels now available, with greatest efficiency and least waste of time and labor. Only by taking advantage of America's war-stimulated research can this nation's overwhelming superiority in productive capacity be fully utilized.

CARNEGIE-ILLINOIS STEEL CORPORATION

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UNITED STATES STEEL

NUMBER 7

MATERIALS AND DESIGN
Cast Irons

Gray Iron Castings—Engineering Properties

These tables give the engineering and physical properties of some typical gray cast irons — both plain and alloy — falling within the familiar A.S.T.M. strength classifications. This material will be included in a forthcoming book (see page 770) on Designing for Quantity Production.

PLAIN GRAY IRONS

Property	A.S.T.M. Class					
	20	25	30	35	40	
Tensile strength, p.s.i.	20,000	25,000	30,000	35,000	40,000	45,000
Compressive strength, p.s.i.	80,000	90,000	100,000	110,000	125,000	135,000
Hardness (Brinell)	110	140	170	200	230	265
Permanent set	5,000	7,000	9,000	11,000	13,000	15,000
Endurance limit	8-10,000	10-12,000	12-15,000	14-16,000	16-20,000	18-22,000
Mod. of elasticity, p.s.i.	11,000,000	12,000,000	13,000,000	14,000,000	15,000,000	16,000,000
Torsion modulus, p.s.i.	4,000,000	4,500,000	5,000,000	5,500,000	6,000,000	6,500,000
Toughness (Izod impact)	———	less than 1	———	———	———	———
Creep 840° F.	———	———	8,000	8,000	no data	no data
0.1%/1000 hrs. 1000° F.	———	———	0	0	———	
Machinability	excellent	excellent	excellent	excellent	good	fair
Wear resistance	good	good	good to exc.	excellent	excellent	good to exc.
Corrosion resistance	fair	fair	fair	fair	fair	fair
Vibration damping capacity	excellent	excellent	excellent	excellent	good to exc.	good
Specific gravity	7.0	7.0	7.1	7.2	7.3	7.4
Melting point °F.		2150-2300				
Thermal exp. $X10^{-6}$	6.7	6.7	6.7	6.7	6.7	6.7
Thermal conductivity (cgs units)	0.11	0.11	0.11	0.11	0.11	0.11
Electrical res. (microhms)	80-100	80-100	80-100	80-100	80-100	80-100
Magnetic permeability (gausses with H at 100)	9000	9000	9000	9000	9000	9000

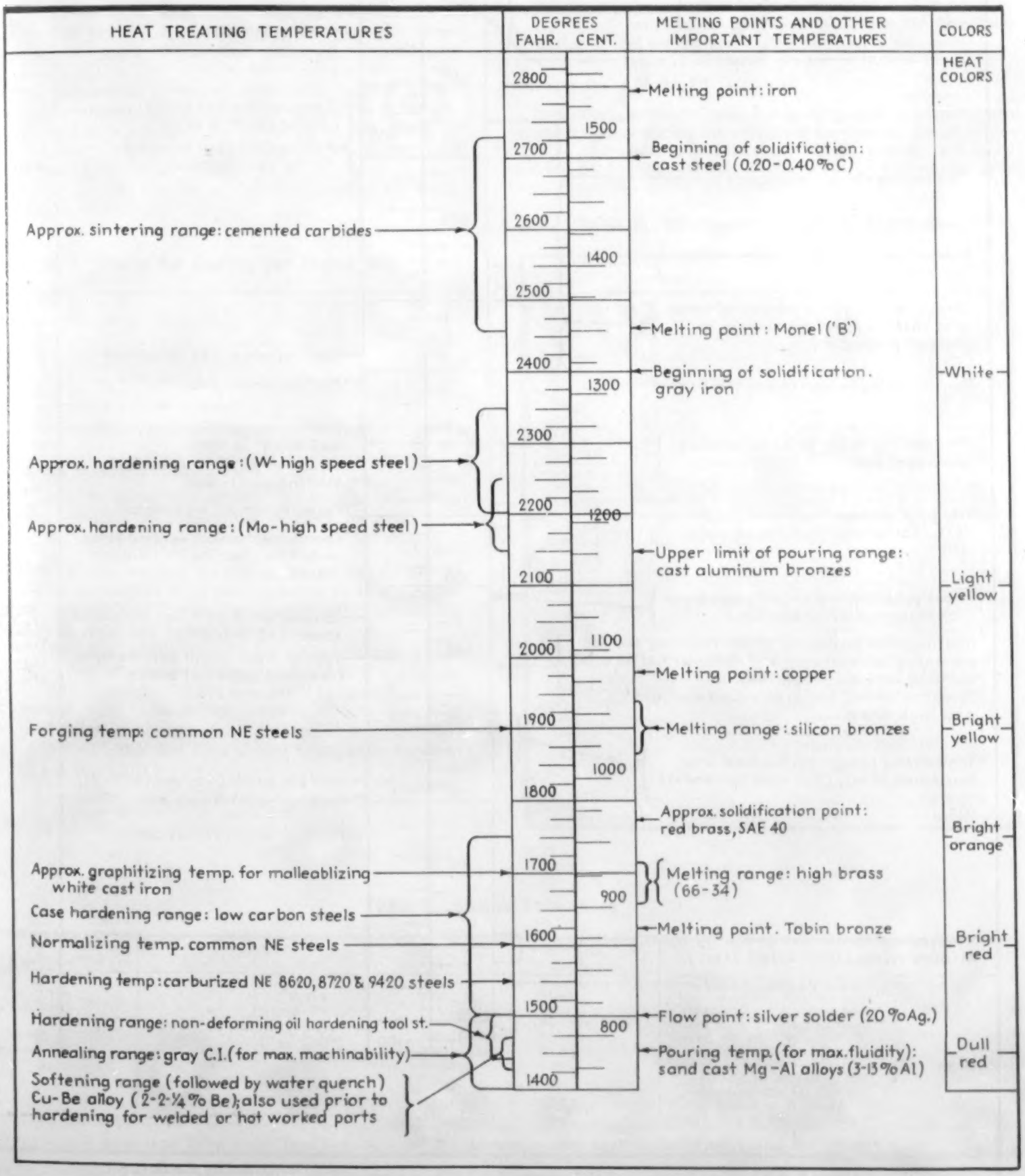
ALLOY GRAY IRONS

Property	A.S.T.M. Class					
	30	35	40		50	60
Tensile strength, p.s.i.	30,000	35,000	40,000	45,000	50,000	60,000
Compressive strength, p.s.i.	100,000	110,000	125,000	135,000	150,000	175,000
Hardness (Brinell)	170	190	210	230	250	275
Permanent set	9,000	11,000	13,000	15,000	17,000	19,000
Endurance limit	15,000	17,000	20,000	22,000	25,000	30,000
Mod. of elasticity, p.s.i.	14,000,000	15,000,000	16,000,000	17,000,000	18,000,000	20,000,000
Torsion modulus, p.s.i.	5,500,000	6,000,000	6,500,000	7,000,000	8,000,000	9,000,000
Toughness (Izod impact)	———	———	less than 1	———	up to 2	up to 2
Creep 840° F.	———	9500	no data	no data	no data	no data
0.1%/1000 hrs. 1000° F.	———	0	no data	no data	no data	no data
Machinability	excellent	excellent	excellent	excellent	good to exc.	good to exc.
Wear resistance	excellent	excellent	excellent	excellent	good to exc.	good to exc.
Corrosion resistance	fair to good	fair to good	fair to good	fair to good	fair to good	fair to good
Vibration damping capacity	excellent	excellent	excellent	excellent	good to exc.	good to exc.
Specific gravity	7.1	7.1	7.2	7.2	7.3	7.3
Melting point, °F.			2150-2300			
Thermal exp. $X10^{-6}$	6.7	6.7	6.7	6.7	6.7	6.7
Thermal conductivity (cgs units)	.11	.12	.12	.12	.12	.12
Electrical res. (microhms)	80-100	80-100	80-100	80-100	80-100	80-100
Magnetic permeability (gausses with H at 100)	9000	9000	9000	10000	10000	10000

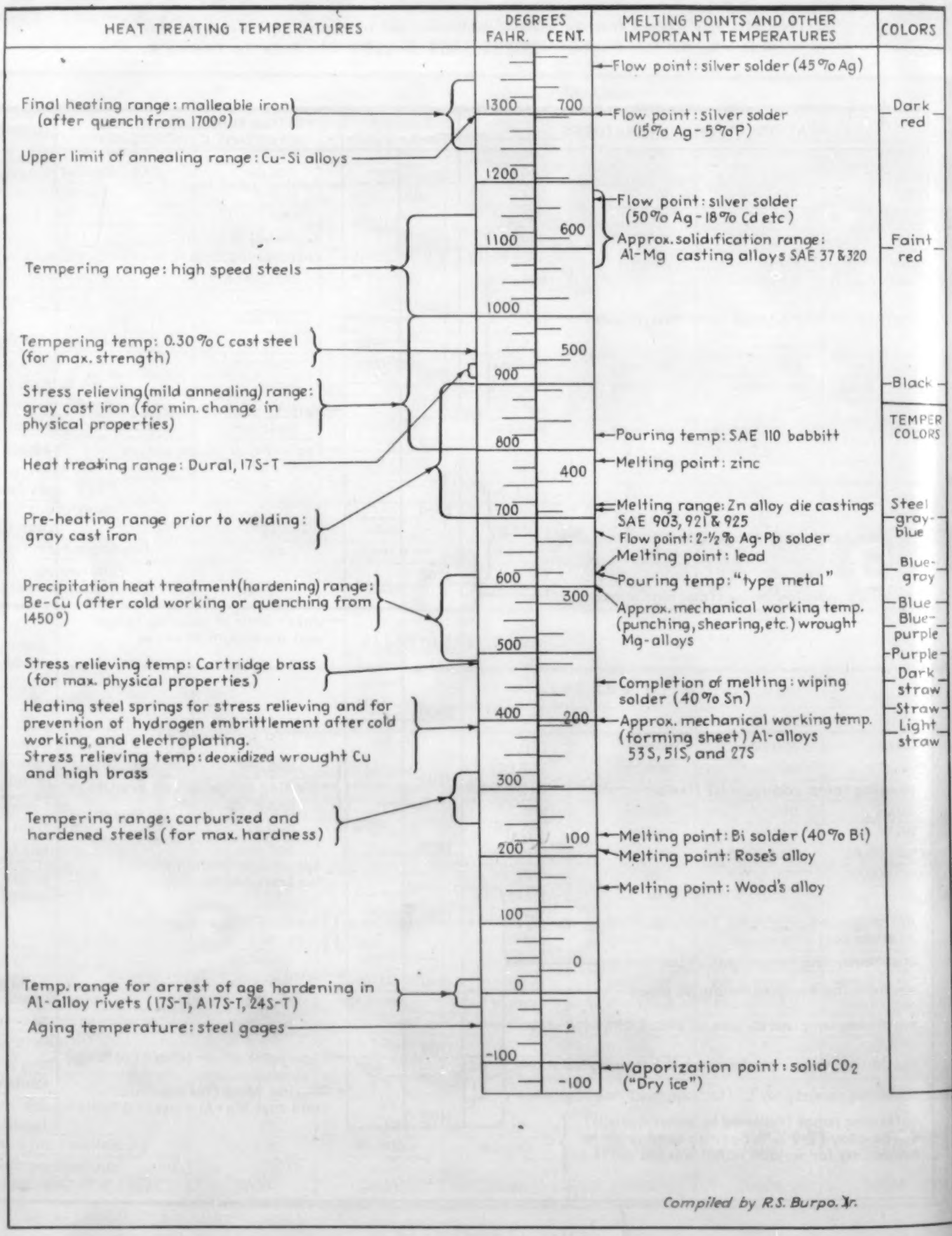
Compiled by Frederick G. Sefing

USEFUL TEMPERATURE DATA

These data were obtained from the following publications and companies: ASM Handbook, 1939 Ed.; Bethlehem Steel Co.; Handbook of Chemistry & Physics, 24th Ed.; Linde Air Products Co.



NUMBER 8 (Continued) **GENERAL ENGINEERING DATA**


HEAT TREATING TEMPERATURES
DEGREES FAHR. CENT.
MELTING POINTS AND OTHER IMPORTANT TEMPERATURES
COLORS
Final heating range: malleable iron (after quench from 1700°)
Upper limit of annealing range: Cu-Si alloys
Tempering range: high speed steels
Tempering temp: 0.30 % C cast steel (for max. strength)
Stress relieving (mild annealing) range: gray cast iron (for min. change in physical properties)
Heat treating range: Dural, 17S-T
Pre-heating range prior to welding: gray cast iron
Precipitation heat treatment (hardening) range: Be-Cu (after cold working or quenching from 1450°)
Stress relieving temp: Cartridge brass (for max. physical properties)
Heating steel springs for stress relieving and for prevention of hydrogen embrittlement after cold working, and electroplating.
Stress relieving temp: deoxidized wrought Cu and high brass
Tempering range: carburized and hardened steels (for max. hardness)
Temp. range for arrest of age hardening in Al-alloy rivets (17S-T, A17S-T, 24S-T)
Aging temperature: steel gages
1300 700
1200
1100 600
1000
500
900
800
400
700
600
300
500
400 200
300
200 100
100
0
0
-100
-100
Flow point: silver solder (45 % Ag)
Flow point: silver solder (15 % Ag - 5 % P)
Flow point: silver solder (50 % Ag - 18 % Cd etc.)
Approx. solidification range: Al-Mg casting alloys SAE 37 & 320
Pouring temp: SAE 110 babbitt
Melting point: zinc
Melting range: Zn alloy die castings SAE 903, 921 & 925
Flow point: 2-½ % Ag-Pb solder
Melting point: lead
Pouring temp: "type metal"
Approx. mechanical working temp. (punching, shearing, etc.) wrought Mg-alloys
Completion of melting: wiping solder (40 % Sn)
Approx. mechanical working temp. (forming sheet) Al-alloys 53S, 51S, and 27S
Melting point: Bi solder (40 % Bi)
Melting point: Rose's alloy
Melting point: Wood's alloy
Vaporization point: solid CO_2 ("Dry ice")
Dark red
Faint red
Black
TEMPER COLORS
Steel gray-blue
Blue-gray
Blue
Blue-purple
Purple
Dark straw
Straw
Light straw

Compiled by R.S. Burpo, Jr.

Shrink Fits

Metallic bushings, sleeves, liners will shrink, or contract, considerably in all dimensions if they are cooled to some temperature below 0° F. After this shrinkage has taken place, the part can be inserted in the receiving member with either a free or a light press fit. By thus shrinking the male part before assembling, the necessity for heavy drive and press fits is removed. This frees presses for other jobs, reduces assembly time, and eliminates the possibility of damage to the insert. Some engineers have specified the shrinking of the insert by cooling and the simultaneous expanding of the female part by gentle heating for easier assembly.

Parts to be shrunk may be cooled in a number of ways; Table 1 lists some of these.

Table 1. Media for Cooling for Shrink Fits

Cooling Method or Mixture	Approximate Lower Limit of Temperature	
	Deg. F.	Deg. C.
Salt (NaCl) and cracked ice	—6	—21
Mechanical refrigeration (single stage)	—50	—46
Mixture of dry ice and alcohol	—98	—72
Solid CO_2 ("Dry Ice")	—110	—79
Mechanical refrigeration (two stage)	—120	—85
Liquid air	—314	—192

Calculating the Shrinkage of Metal Parts

The change in linear dimensions of metals and alloys caused by a variation in temperature is given by equa. (1).

$$L_2 = L_1 (1 + AT) \qquad (1)$$

Where L_1 is the original length at room temperature of some specified dimension; A is the coefficient of linear expansion of the material; and T is the temperature difference causing L_1 to change to some new value, L_2.

Table 2 lists the coefficients, A, for some common metals and alloys. Since we are calculating shrinkage, A is a negative number.

An example will illustrate the way in which equa. (1) can be used when computing the shrinkage of a 2.000" OD bushing (SAE 62) that has been cooled from room temperature (70° F.) to —40° F.

$L_1 = 2.000''$, $A = -0.0000097$ (see Table 2), and $T = 70° - (-40°) = 110°$
$L_2 = 2.000\ (1 - 0.0000097 \times 110) = 1.998''$

From this we learn that a bronze (SAE 62) bushing 2.000" OD at 70° F. will shrink about 0.002" when cooled to —40° F.

The same equation is used in calculating the expansion of heated parts; the coefficient A is positive in this case.

Allowances and Shrink Fit Tolerances

Both the allowances and the mating part tolerances used when designing shrink fits vary with conditions. Large shrinkages of the insert are unnecessary if the mating part is expanded by heating. Table 3 lists some of the current practices regarding shrink tolerances.

Table 2. Coefficients of Linear Expansion

Material	Condition	Coefficient of Expansion (A)
Aluminum Alloys		
No. 112 SAE 33	Sand Cast	0.0000122
No. C113 SAE 33	Permanent Mold Cast	0.0000122
No. 195 SAE 38	Sand Cast	0.0000127
No. 81 SAE 312	Die Cast	0.0000122
No. 214 SAE 320	Sand Cast	0.0000133
No. 220T4 SAE 324	Sand Cast	0.0000134
No. A132 SAE 321	Sand Cast	0.0000105
No. 356 SAE 323	Sand Cast	0.0000119
No. A51S SAE 280	Wrought	0.0000130
No. 17S SAE 26	Wrought	0.0000132
Copper Alloys		
Yellow Brass SAE 41	Sand Cast	0.0000106
Manganese Bronze SAE 43	Sand Cast	0.0000108
Hard Bronze SAE 62	Sand Cast	0.0000097
Naval Brass SAE 73	Wrought	0.0000112
Aluminum Bronze SAE 701	Wrought	0.0000095
Iron, Gray SAE 110	Sand Cast	0.0000062
SAE 111	Sand Cast	0.0000059
Iron, "Malleable"	Malleableized	0.0000066
Magnesium Alloy SAE 50	Sand Cast	0.0000015
Monel B	Wrought	0.0000078
Steel		
SAE 1020	Annealed Bar	0.0000065
SAE 1022	Sand Cast	0.0000070
SAE 1040	Annealed Bar	0.0000052
SAE 1095	Bar	0.0000064
SAE 2330	Annealed Bar	0.0000061
SAE 3145	Quenched and Tempered, Bar	0.0000066
SAE 4140	Bar	0.0000062
SAE 6150	Quenched and Tempered, Bar	0.0000064
Stainless, 18-8	Annealed Bar	0.0000093
Tungsten Carbide (WC + 13% Co)	Sintered	0.0000033

Table 3. Shrink Tolerances

Basic Dia. of Insert in Inches	Shrinkage Min.	Shrinkage Max.	Shrink Tolerance ±	Material	Remarks
0.437	0.0015	0.002	0.00025	Bronze	Fitted into a Mg-alloy body*
0.468	0.003	0.005	0.001	Steel	Fitted into an Al-alloy body*
1.565	0.004	0.006	0.001	Steel	Fitted into an Al-alloy body*
1.822	0.004	0.006	0.001	Ni-Cast Iron	Fitted into an Al-alloy body*
2	0.001	0.0015	0.00025	Steel	Cooled 40 min. at —50° F.
2.285	0.005	0.007	0.001	Al-Alloy	Fitted into an Al-alloy body*
	—	—	0.005	Steel	Cooled 1 hr. at —40° F., while female part (steel) is heated to 400° F. for 1 hr. (expanding the ID 0.002")
3.062	0.0035	0.008	0.00425	Al-Alloy	Fitted into a steel liner*
3.440	0.002	0.006	0.002	Steel	Fitted into a Mg-alloy body*

* While the male parts were being cooled from —35 to —40° F., the female parts were expanded by heating to 300-450° F.

Data in Table 3 taken from "Cold Treatment of Metals," by Phair, *The Iron Age*, Vol. 151, Feb. 25, 1943, p. 37.

Compiled by Robert S. Burpo, Jr.

GALVANIC CORROSION

OF DISSIMILAR METALS

And how you can confound milliampere Gremlins at their own game

Today, dissimilar metals must frequently be used in more or less untried combinations. This is made necessary by metal shortages and urgent production needs.

Such combinations when exposed to liquids or moisture can result in serious galvanic corrosion, though, since its effects are not readily distinguished from those of the ordinary types of corrosion, it frequently is blamed for troubles it could never cause.

Yet when really present, galvanic corrosion may be very serious. As a result, galvanic couples now merit much closer attention by designers than was previously necessary.

Practices for Controlling

1 Select combinations of metals as close together as possible in the Galvanic Series.

2 Avoid combinations where the area of the less noble material is relatively small. It is good practice to use the more noble metals for fastenings or other parts in equipment built largely of less corrosion resistant material.

3 Insulate dissimilar metals wherever practical. If complete insulation cannot be achieved, anything such as paint or plastic coatings at joints to increase the resistances of the circuit will help.

4 Keep dissimilar metals as far apart as possible. This rule applies even when the actual connection between the metals is made external to the corrosive liquid.

5 Apply coatings with caution. For example, when painting—do not paint the less noble material without also coating the more noble, otherwise greatly accelerated attack may be concentrated at imperfections in coatings on the less noble metal. *Keep such coatings in good repair.*

6 If practical, add chemical inhibitors to the corrosion solution according to the nature of the solution to be inhibited.

GALVANIC CORROSION AND HOW IT ACTS

When two unlike metals are connected to each other in any corrosive liquid as, for example, brine, one metal is often attacked at a much faster rate than usual. The other metal either remains free from attack, or is corroded at a considerably slower rate than usual. Because corrosion of this type is always associated with the generation of an electrical current, it is described as "galvanic corrosion."

It is this galvanic effect that speeds up the corrosion action beyond an ordinary rate. The metal which is corroded by this action is said to be "anodic"* and the metal which it more or less protects is termed "cathodic"*.

An excellent, simple example of galvanic corrosion is found in an ordinary battery (dry cell) or a similar galvanic cell where a zinc anode (less noble) suffers accelerated corrosion while a copper cathode (more noble) is virtually unaffected. The battery, too, exemplifies generation of the electric current associated with galvanic corrosion action.

*Corrosion engineers also speak of the cathode as the "more noble" metal and the anode as the "less noble" metal—using the word "noble" in a broader sense than its original meaning in the case of precious metals such as gold and platinum.

THE INTERNATIONAL NICKEL COMPANY, INC.

METALLURGICAL ENGINEERING shop notes

Self-Adapting Work Support Ring

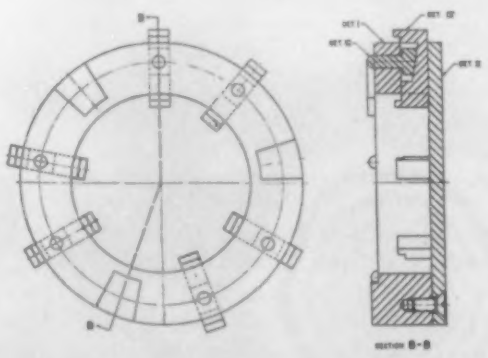
by Bertram Hatfield,
Wright Aeronautical Corp.,
Cincinnati, Ohio

A change in the sequence of operations in the manufacture of a clutch disc for Cyclone 14's brought the work to the lathe from heat treat in a warped condition. The parts are thin and, due to the meager support offered by the 3 chuck jaws previously employed, the work has a tendency to spring away from the tool as the unsupported parts turned past.

Due to the warp, no solid backing would support the work uniformly, since the work would touch such backing only at the high points. Hence, a self-adapting device flexible enough to produce flat work despite the unavoidably warped condition of the parts had to be developed. The ring helps eliminate the need for second and third cuttings, and especially for rework on the gears.

The only function of the support ring is to prevent the work from springing away from the facing tool, supporting the work, not at three, but at nine equally-spaced points.

The three fixed points consist of raised surfaces on the front of Detail I (see



sketch). The other six are pins, which have a limited free motion parallel to the axis of the ring, located on a circle about 1 in. smaller than the diameter of the parts. A rectangular slot is milled through the back of the ring at each of the six

pin holes, its center line coinciding with the radius of the support ring that passes through the center line of each hole. The slot then forms three sides of a rectangular hole; the back plate (Detail II) forming the fourth side.

Inserted in, and free to move toward and from the center of the ring is Detail IV. The 10 deg. angle on this detail, when pushed away from the center of the ring, exerts a wedging or cam action on the angular bottom of the pin, forcing the pin toward the work. The angle is such that no reciprocating pressure on the end of the pin can force Detail IV to slide back toward the center. The pin, therefore, cannot retract as long as Detail IV does not slide back, and the pin can only emerge from its hole until the ball point touches the work, no farther.

If the work is chucked up with the ring behind it, the work touching the ring at the three raised points and all pins away from the work, pushing Detail IV away from the center, will force each pin out until it touches the work. If the chuck is then started up to a speed of about 300 r.p.m. (carbide tools being used), centrifugal force will hold Detail IV in contact with the bottom ends of the pins which, now being non-retractable, will support the work firmly until the operation is complete, thus eliminating second and third cuts.

[*The author received a Certificate of Individual Production Merit from the War Production Board for this device.*—Editor]

Air Salvages Chips Into Barrel

by Roger Greene,
General Electric Company

The blowing of chips from a lathe into a closed barrel effects 100 per cent salvage and keeps the scrap segregated and uncontaminated. The device was first applied to an automatic lathe used in machining the bore of babbitt-lined, steel-shell motor bearings. Ordinarily, the chips fly around on the machine and the floor.

The lathe has a hollow spindle and was originally piped for cutting oil through the turret stem. Work is held in a universal air-operated chuck, and the hole is continued through it and the air-operating cylinder at the back. The oil piping system is connected to the shop air line and compressed air directed through the bearing during the boring. The chips are carried through the spindle where they are caught in a sheet-iron pipe leading into the chip barrel.

Gage Cut in Two, Remounted

By Emil Komuves,
740 E. 221st St., New York

A standard "Go-No Go" gage was cut in half in our shop and remounted, using the same original parts plus two additional mounting screws. This proved to have been another way of speeding war production.

Advantages of my idea are at least four: The gage is held firmly in a convenient and comfortable position; no turning of the gage is necessary; there is less chance of error; and the actual time of checking parts is cut 50 per cent.

Figure 1 illustrates the standard gages used in plants throughout the country because of its simplicity of manufacture and

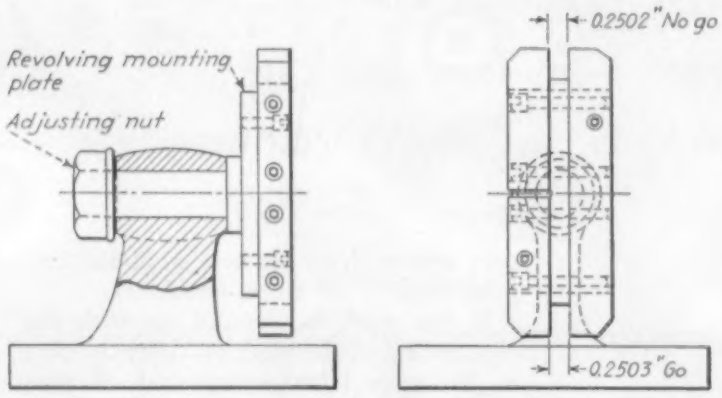


Fig. 1

servicing. Here the mounting plate is revolved by the inspector for checking the diameter of each individual part. As many as 27 separate operations were sometimes involved for parts having as many as nine different diameters.

The part to be checked was inserted into one end, removed, the other mounting plate revolved 180 deg. and the part tried into the other end. Three main disadvantages were: Time involved in revolving gage; difficulty of revolving when the nut was tightened too much; and revolving of the gage when too loose and revolving past the desired position.

Figure 2 shows the modified gage, where the original gage was cut in half.

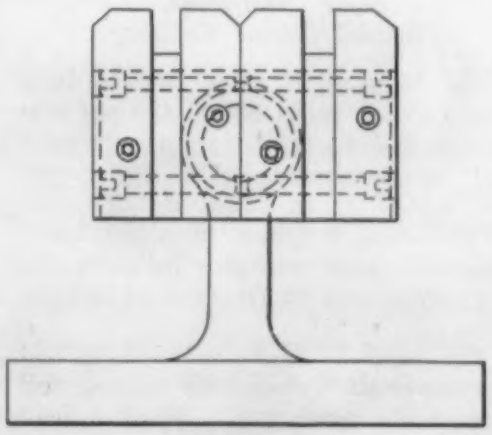


Fig. 2

The two resulting gages are mounted side by side and can be tilted and tightened into any angle convenient to the operator or inspector. The gage is then tightened and left in this same position by the operator while he checks all his parts.

[The author of this sketch was awarded a Certificate of Production Merit by the War Production Board for this scheme.—Editor.]

Mirrors Measure Hot Steel Plate

by E. D. Wilson,
Westinghouse Electric & Mfg. Co.

A system of mirrors has been devised by Westinghouse to enable workmen to measure at a glance the width of yellow-hot steel slabs rolling shoulder high from the mill. In most plants plates travel on a table just above the floor, and can be measured with a long gage. But with a new armor-plate mill, the product comes out too high.

The new mirror system works 20 ft. on the side of the rolls. A square of cardboard is painted red and covered with light to represent the glowing metal. A black paper chart, with white lines showing the proper plate width, is mounted off to one side. One set of mirrors is arranged to catch an image of the actual glowing steel and a second set is aimed at the chart. Both of these images are directed into a mirror so that the white lines are superimposed on the image of the steel plate.

In practice, plates that fill the space between the lines would be sent on to be rolled into sheets. If the plate is too narrow, the operator, through the mirror system, can easily estimate the amount of additional pressure needed.

Chrome painting is being substituted for galvanizing for some types of ship plates, due to shortage of zinc. It will not give as durable protection as galvanizing, but will last for the duration. Its use also speeds production.

—A. J. Diebold, President, Hanlon Gregory Galvanizing Co., Pittsburgh.

Spot Test for Molybdenum In Steel

by Joseph A. Duma & W. F. Everett,
Navy Yard, Portsmouth, Va.

To the list of rapid identification tests featured in the August 1942 issue of METALS AND ALLOYS, pages 264-266, the authors wish to add one more, a chemical spot test for molybdenum. This newly developed test is comparable to the well-known dimethylglyoxime test for nickel. It is designed not only for the segregation of metal scrap, but for the welding engineer, who must know the composition of the metal before he can prescribe welding procedure for repairing "in situ."

This test is quickly executed, requiring practically no specialized training or skill. The results are positive and, if rightly done, semi-quantitative. It can detect molybdenum as low as .15 per cent.

Procedure: (1) Place one drop of 1:1 nitric acid on a cleaned area, letting it react 10-15 secs. To this drop add one to two drops of concentrated hydrochloric acid. (Reagents 1 and 2): (2) Transfer reaction solution via a capillary pipette onto a piece of white photographic blotter; (3) Cover the moist spot on the blotter with a drop or two of stannous chloride solution (Reagent 3). Spot should be completely colorless; (4) Add to this same moist spot one drop of sodium thiocyanate. (Reagent 4); (5) A pink fleck or ring indicates molybdenum. The pink coloration develops around the edges first, faintly while the spot is wet, more pronouncedly as the spot dries.

Reagents in Order of Application:

Reagent 1—50 cc. water and 50 cc. nitric acid (sp. gr., 1.42);

Reagent 2—100 cc. hydrochloric acid (sp. gr. 1.05);

Reagent 3—Stannous chloride solution (dissolve 25 grams stannous chloride in 35 cc. concentrated hydrochloric acid. Use gentle heating for faster dissolution of the stannous chloride. Dilute to 100 cc. by adding cold distilled water. Keep solution in dark bottle. Add few shavings of metallic tin to same to keep it from oxidizing);

Reagent 4—5 grams sodium thiocyanate and 95 cc. distilled water.

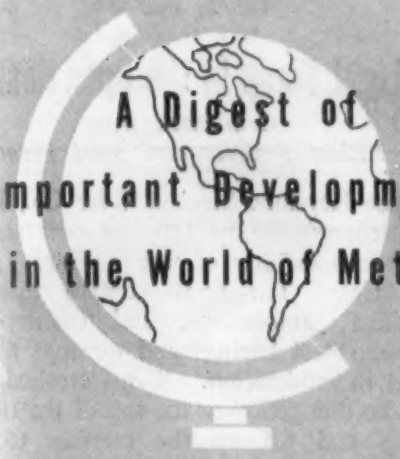
Where two metal parts rub together, causing friction and wear, it is often wise to transfer the wear from the more expensive to the less expensive part. Such a principle is being observed in a steel mill in the case of a blooming mill steam engine. Cast iron piston heads are brazed with manganese bronze rods. The entire outer surface is built-up and machined to size. Thus, by transferring wear from cylinder to the less costly piston head cylinder, life is trebled.

—*Airco News*, Nov.-Dec. 1942, Air Reduction Co.

Stringer beads, in concentric circles, rather than a solid deposit, were placed on a road disc to keep it concentric and prolong its life. A welder applied stringer beads of 3/16-in. 20-30 electric tube borium, made by the Stoody Co. One county highway department using this method of hard-facing reports a saving of $32 from each operation.

—"Fusion Facts," Stoody Company

Metallurgical Engineering Digest



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1 Metal Production

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Furnace Insulation

Condensed from "Canadian Metals & Met. Industries"

Important fuel savings are possible in all types of furnaces. Maximum efficiency can be attained only by continuous operation, maintenance of minimum fuel consumption, and maximum protection of working men against radiated heat.

High temperature insulation has been developed which consists of a great number of air pockets surrounded by powdery, micaceous or fibrous material. High temperature insulation may be placed in two classes.

The first type (light weight insulation) is extremely light in weight and of very low heat conductivity and is used as a backing for refractories at temperatures up to 1600 deg. F. The second type ("refractory insulation") is an insulator that can stand direct contact with flame and furnace temperatures up to 3000 deg. F. The base of the first class is vermiculite, diatomaceous earth, 85 per cent magnesia or mineral wools.

The heat conductivity of any material "K" indicates the number of B.t.u.'s which will pass in 1 hr. through a 1 sq. ft. of the material, 1 in. thick when the temperature differential between the hot and cold faces is 1 deg. F. Its value is roughly proportional to the weight of the insulating material per unit volume.

Forms of insulation application, the manufacture of refractory insulating brick, coatings and joining cements are briefly discussed. The use of insulation in the open-hearth is made possible by the use of vermiculite base (expanded mica) insulation. On new furnaces the regenerator walls and floor below ground level are frequently insulated with insulating concrete and the wide walls above the ground are insulated with 2½-3 in. of block insulation.

The bulk heads of the regenerators are insulated with coating which can be scraped off the brick work and recovered when the regenerators or slag pockets are opened up for cleaning.

Advantages of heat insulation of open-hearth furnaces are: (1) Lower fuel consumption per ton of steel produced, (2) air infiltration into the furnace is largely eliminated, (3) spalling losses from silica brick are less severe due to conversion of quartz to more stable mineral forms, (4) slag pocket accumulations are less since the volume and velocity of products of combustion are decreased in the same ratio as fuel consumption is decreased, also the carry-over into the checkers and (5) a saving in time of production of a heat.

—G. W. Paterson, *Can. Metals & Met. Inds.*, Vol. 6, Jan. 1943, pp. 6-11, 33.

Light Scrap in the Open-Hearth

Condensed from "Blast Furnace and Steel Plant"

The Keystone Steel & Wire Co., Peoria, Ill., charges 80 to 100 per cent scrap in the manufacture of the ordinary grades of steel. The scrap consists chiefly of farmers', automobile, and country-mixed scrap. Steel borings and turnings are also used in moderation. When crushed, these can be dumped over the top of the heaviest scrap and fill up the crevices to good advantage.

The scrap is received at the plant as it is collected and is prepared in its own yard. The material is cut into pan lengths, either by gas or large alligator shears. Sorters are paid a bonus to remove bearings, brasses, and other undesirable alloys. Different grades of scrap are segregated throughout the yards so that they can be used on different types of heats. Much more scrap is loaded into the pans by trimming while loading.

Two charging-machines are used in charging three 175-ton furnaces. This permits simultaneous charging of two furnaces or making additions to one furnace without holding up charging on another. An overhead crane and magnet clean the floor of scrap after charging. One or two pans of heavy scrap are charged with each car of light scrap to offset the loss in weight.

Some heavy scrap is charged in the early part of the heat, so that weight will be in the furnace in case of a delay. Part of the lime is charged about the middle of the charging cycle when using light scrap. This lime will come up early and protect the banks from the oxidizing conditions of the bath. A very sharp-working furnace is essential, as it must be filled many times and melted quickly.

Some time is usually lost in melting these light scrap charges, as only a limited amount can be charged. Then it is necessary to wait until the cut is lowered before proceeding with the charging.

The life of the furnace is most seriously affected. The flame is forced around the bulky scrap and into the roof and back and front walls, shortening the life of the refractories. The banks also require more attention because of the washing action of the flame.

Zinc, lead, and tin on baled wire and sheet seriously affect furnace operation when used injudiciously. The zinc is car-

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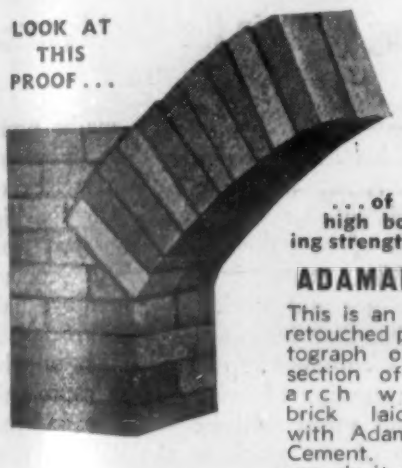

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ried through the downtakes by the flame, and eventually assists in clogging the checkers. The lead seeps into the bottom and in time causes either lost time or a lost heat.

Light scrap has no tangible effect on quality provided it is free from contaminating elements, and adjustments are made to compensate for the extra oxidation during melting. Copper has a somewhat detrimental effect on rolling quality when over 0.20 per cent. The effect of tin is much greater and becomes more pronounced as the carbon increases. A definite embrittling effect from 0.020 per cent Sn has been found in steels with 0.75-0.90 per cent C. The percentage of tin in light scrap seems to be in almost direct proportion to the carbon content.

Use of additional manganese in the heat tends to offset the hot-short effect of the tin, but set manganese specifications must be conformed to so that the steel will meet physical requirements. Therefore, the utmost precaution must be exercised in selecting charges for the different grades of steel.

—E. H. Reyer, *Blast Furnace & Steel Plant*, Vol. 31, Feb. 1943, pp. 205-207.

Pig Iron and Steelmaking

Condensed from a paper for the Am. Inst. of Mining & Metallurgical Engs.

Much discussion of the open-hearth process is in terms of one heat or one furnace. Problems that are affected by the number of furnaces operating, by the number of blast furnaces in the plant and by the fact that the open-hearth shop is dependent on the blast-furnace capacity rather than on its own needs for the amount of iron available are among those which in contrast to "unit operations" are called "total operations."

Two problems which illustrate this thesis are: (a) The use of open-hearth slag in the blast-furnace burden; (b) a study by multiple linear regression of some factors affecting the production of the open-hearth shop.

The Problem of Phosphorus

The problem of phosphorus is present whenever basic open-hearth slag is used in the blast-furnace burden. The slag analysis and percentage of open-hearth slag in the burden furnish an incomplete description of the phosphorus problem because it considers one blast furnace as a unit.

A phosphorus balance for a unit of all blast furnaces and all open-hearth furnaces receiving iron from them is worked out much as a burden sheet is made for one furnace. Here too a change does not have an immediate effect, but takes time to come through. In the phosphorus cycle of the plant, samples can be taken at various stages during the change for additional information.

Over a sufficiently long period or during any short period when no change is going through the system, the weight of phosphorus entering the system is equal to the weight of phosphorus leaving the system. If no high-phosphorus steel is made, the phosphorus content of purchased scrap and that of the finished steel are compensating and may be neglected. With no open-

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- **Rite-Melt Cleanser**—put in furnace during charging or in ladle.
- **Rite-Sulphur Reducer**—put in ladle.
- **Rite-Stool Protector**—put on center of stool.
- **Rite-Moldcote**—can be easily sprayed and is economical to use.

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Levigated Chromic oxide

Mild Polish
Levigated tin oxide

Sharp Polish
Levigated cerium oxide

hearth slag in the burden, the weight of phosphorus introduced equals the weight of the iron. This weight of phosphorus leaves the cycle in the open-hearth slag.

With open-hearth slag on the burden, the analysis of both the iron and open-hearth slag increases until the weight of phosphorus leaving the cycle is equal to the new phosphorus introduced. The controlling consideration is the proportion of open-hearth slag returned to the blast furnace; what part of the blast-furnace burden is made up by this weight of open-hearth slag is incidental.

Open-Hearth Production

At the present time the goal of open-hearth operation is to make the most effective use of available materials. The interrelation of several factors that determine open-hearth production is shown by multiple regression. Production is stated in number of heats per day, selected as the dependent variable. To eliminate accidental influences affecting the production of a single day, averages of a 5-day interval are used.

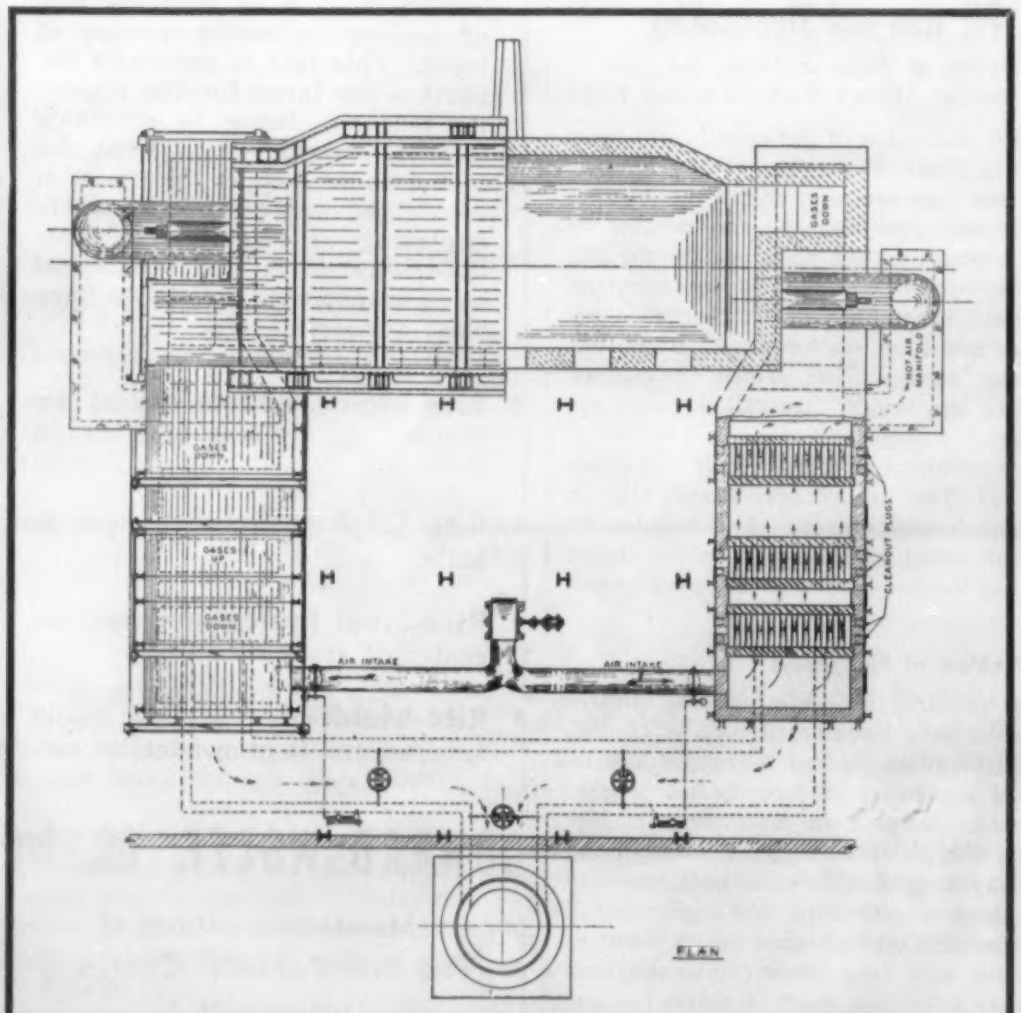
The four factors of the regression equation are: Number of furnaces; tons of metal to open-hearth; metal in open-hearth charge, per cent; weight of boxes of scrap, lbs. The first two are of the greatest and about equal importance and the others secondary, but again about equal.

The equation shows that aside from putting another furnace into operation, the most effective way to increase open-hearth production is to increase that of the blast furnace. The percentage of hot metal has a negative coefficient because in total operation the problem is how best to proportion the charge including charge ore, to make the best production.

As large an amount as possible of metal should be as small a percentage as possible of the total daily charge. The beneficial influence of heavy scrap is also shown. Replacing, in the blast furnace, 200,000 lbs. of light scrap weighing 500 lbs. per box, by heavy scrap averaging 3,000 lbs. per box, shows an increase of 80 tons of hot metal and of 0.19 heats per day.

—William C. Marshall & Frank G. Norris, *Preprint, Am. Inst. Mining & Met. Engrs.*, T.P.1571, Feb. 1943 meeting, 7 pp.

"FITCH" RECUPERATORS
For OPEN HEARTH



WHY REVERSE?

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OPEN HEARTH LETTERS

FITCH RECUPERATOR CO.

PLAINFIELD NATIONAL BANK BLDG. PLAINFIELD, NEW JERSEY

Smelting Sinter in the Blast Furnace

Condensed from "Steel"

Efficient use of heat is the major problem of blast-furnace operation. The gas column rising through the interstices of the stock column is the agent for the distribution of heat throughout the stock column. The more intimate the contact between gas and stock and the more uniform the distribution of gas throughout the stock column the more efficient will be the transmission of heat and the more uniform and rapid will be the rise in temperature of the stock to the desired temperature.

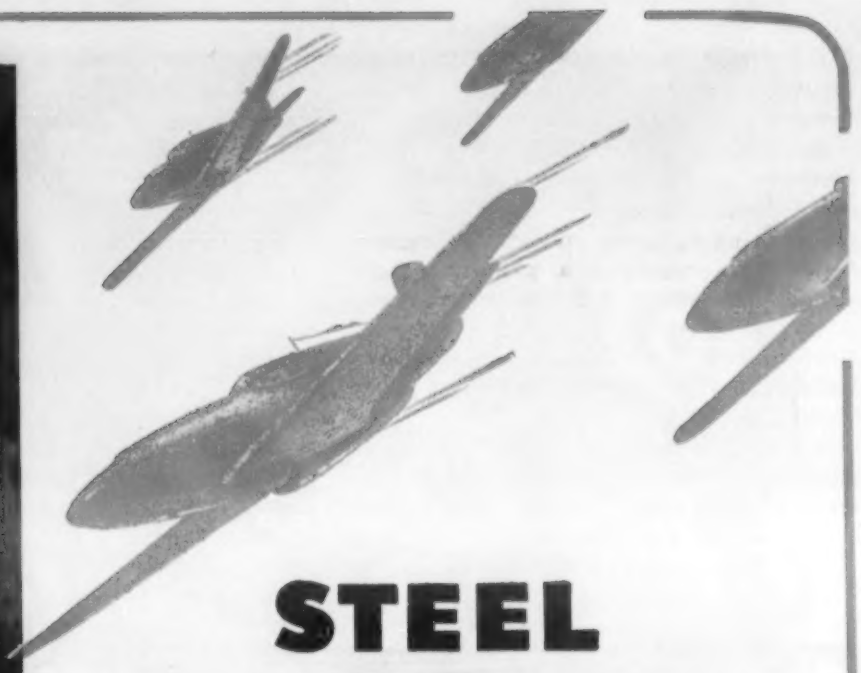
The ideal iron-bearing material for blast furnace use is rich in iron, low in gangue, free from volatiles, and a good conductor of heat. It should have sufficient structural strength to prevent packing in the furnace and the particle size range should be such as to force the maximum contact between the descending stock and ascending gas, consistent with a free uniform passage of the gas.

Such materials seldom if ever exist in the natural state, but they can be approached by beneficiating natural materials. Full beneficiation includes concentration, sintering, and sizing.

Sinters are free from volatiles, conduct heat readily, absorb it uniformly, and hold it. To get the full benefit of these virtues in a total sinter burden, particle size must be small to force maximum contact between the sinter and the furnace gas.

Fines are desirable for transmitting heat as rapidly as possible from gas to stock. Some larger sizes are needed for free passage of the gas through the interstices of the stock. The desired minimum in particle size is that size which will not easily be entrained in the gas stream. The desired maximum is that which is small enough to form a compact and self-supporting stock column. A sinter graduated from —1 in. to —100 mesh with as large a percentage of the smaller sizes as freedom of gas will permit serves both purposes very well.

The granular characteristic and structural strength of the sinter particles prevent packing and thus equalize the resistance to the flow of gas and force the gas uniformly throughout the stock column. The cellular structure of the sinter particles provides a large ratio of surface to mass



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bottom repair

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Every month more steel plants are using Hearth Patch for emergency repair work. Over 40 shops have ordered it since Pearl Harbor. Some average a carload or more per month.

Hearth Patch is a dense, fine-grained, quick-setting magnesite refractory that you simply shovel or dump into the hot furnace. You mix no slag with it. Just clean out the bottom hole carefully, fill it level full of Hearth Patch. Dress the repaired area with two inches of burned dolomite or magnesite, and the entire patch consolidates quickly into a solid repair.

Hearth Patch has its limitations. Don't put it in a cold furnace. And if you use it for bank repairs, mix slag with it.

Basic Service Engineers, who are helping many shops to save hours of production time with Hearth Patch and other Basic Refractories' products, will be glad to aid you, too. Think of these long-experienced, practically trained men as your refractories specialists.

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PRODUCERS OF MAGNESITE AND DOLOMITE HEARTH MATERIALS FOR STEEL FURNACES

for gas contact and so permits the maximum opportunity for transmission of heat from gas to stock.

Such sinter makes desirable a smaller particle size of coke than is usual with soft ore operation. Size of —3 in. to +1 in. has been used in sinter operations successfully. This results in a more compact stock column, offering a maximum uniform resistance to gas flow, but free from restrictions to flow common to soft ore. Resistance to gas flow conserves heat in the furnace.

Sinter stock column permits the use of much higher hot-blast temperature. In actual full-scale operation 1850 deg. F. has been used without difficulty.

With no heat-absorbing volatiles present and the ability to recover and use a greater percentage of the latent heat of the fuel by use of a high blast temperature, the blowing rate can be reduced and so conserve much of the heat normally taken from the furnace with the gas. Results are an increase in production and a decrease in fuel rate. The blowing rate of any furnace should be based upon the character of the materials used and not upon furnace lines.

Use of properly sized sinter and conditioned air appears to be the closest approach to theoretically perfect blast-furnace operation.

Iron silicates formed during sintering are very important for the structural strengthening effect imparted to the sinter. This effect increases with the percentage of such silicates in the sinter and with the percentage of iron in the silicate. Excessive strength can be just as objectionable as too little because it prevents the natural formation of the preferred particle size of sinter for blast furnace use.

—Charles E. Agnew, *Steel*, Vol. 112, Feb. 15, 1943, pp. 100-102, 104, 135-139; Feb. 22, 1943, pp. 88-90, 94, 97.

Aluminum—International Trends

Condensed from "Foundry Trade Journal"

The "Economist" has recently estimated that from 1937 to 1941 the world output of virgin aluminum approximately doubled, reaching just under one million tons. Precisely what is going on during the war is obscure. In all the countries where output has expanded, new works and extensions have been built. More economic use is being made of scrap, and wider use is being made of aluminum down to about 98 per cent purity where formerly 99 per cent and upwards was specified.

Experiments aimed at securing stronger alloys have been made in several countries. American experts are trying to get away from the duralumin series, while the Germans are specializing in silicon and magnesium alloys.

The report of the Vereinigte Aluminum Werke A.G. for 1940 mentioned that new fields of application for aluminum were being opened up in the chemical and engineering trades, and improvements in surface qualities were opening up new fields in interior decoration, foodstuff packing and electrical engineering.

Explosive aluminum rivets have been evolved, in which a charge of high explosive inside the rivet takes the place of the riveting hammer. Permanent mold and die castings have been improved, which will prove especially valuable if quantity production is needed after the war.

—M. P. Fogarty, *Foundry Trade J.*, Vol. 68, Dec. 17, 1942, pp. 339-342.

Desulphurization of Iron

Condensed from "Archiv. Eisenhüttenwesen"

Thermodynamic considerations show that the effect of magnesium oxide, manganous oxide, lime and sodium oxide in desulphurization increases considerably in the order named. Desulphurization by manganous oxide-ferrous oxide-SiO_2 slags is discussed and an approximate desulphurization diagram developed. Additions of alumina reduce the desulphurizing capacity of these slags considerably.

Desulphurization with both acid and basic lime-ferrous oxide-SiO_2 slags is investigated and shows that the distribution factor increases with the carbon content of the bath and the basicity of the slags. Desulphurization is not appreciably influenced by fluorspar.

—J. Görissen, *Arch. Eisenhüttenw.*, Vol. 15, Feb. 1942, pp. 347-350.

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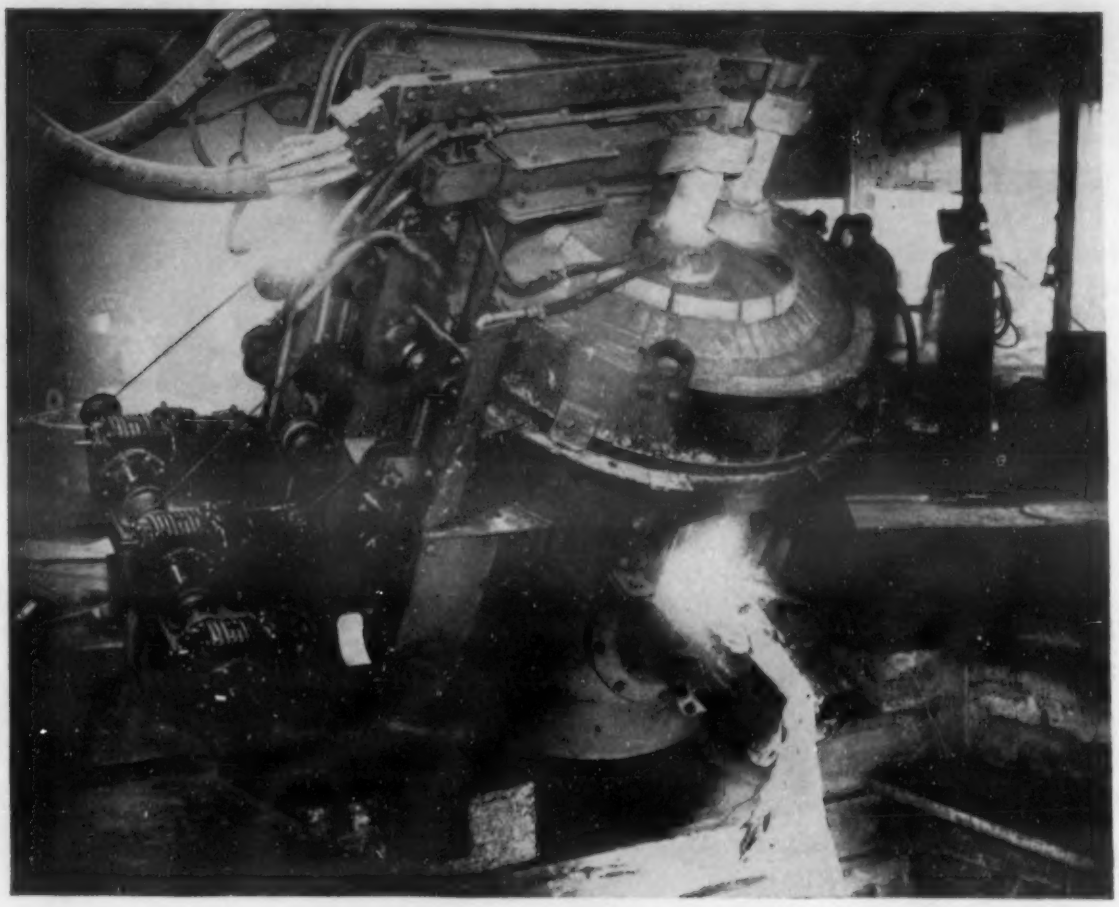

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Are you having trouble with short roof life on your Direct Arc Furnaces? If you are, now is the time to check the advantages to be gained by using P. B. SILLIMANITE roofs. These roofs are in service today on a variety of furnace sizes—from 50 lb. to 50 tons—melting a wide range of steels and alloys. Where the operating conditions are just too t-o-u-g-h for ordinary refractories P. B. SILLIMANITE is doing the job—at a definite saving in refractory cost per ton of metal, even though the initial cost is higher.

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1—Softening point above 3100° F.	1—P. C. E. of Cone 38—3335° F.
2—High Hot Strength	2—Being a relatively pure, crystalline compound of alumina and silica, stabilized as mullite (3 Al_2O_3:2 SiO_2), there is no gradual softening below the critical point.
3—High Spalling Resistance	3—No loss in standard ASTM Panel Spalling Test for Super-Duty Fire Brick—a product which is designed for high spalling resistance. No abrupt volumetric changes.
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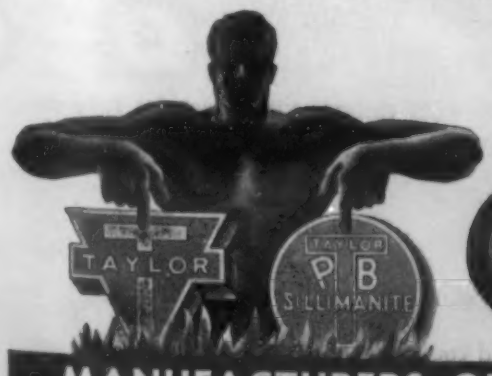

Either P. B. SILLIMANITE Ramming Mix or Brick and Shapes are supplied for the roofs of the smaller furnaces—1,000 lb. and under. Brick and Special Shapes are recommended for the larger roofs. Write today for your copy of Bulletin No. 311 and other interesting data.

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2 Foundry Practice

Melting and Pouring of Gray Iron, Malleable, Steel, Brass and Bronze, Aluminum and Magnesium Castings • Molding, Core-Making, Gating and Risering, etc. • Foundry Furnaces, Refractories, Ovens, Molds, Sands, Binders, Auxiliary Equipment and Materials

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Steel Castings for Low Temperatures

Condensed from "Transactions," American Society for Metals

The problem of making economical low-alloyed steel castings to meet the tentative specification of 15 ft.-lbs. Charpy impact resistance at —100 deg. C. may be considered basically solved. In order to present industry with technical evidence, which could be directly applied to commercial production, work has been conducted on a semi-commercial and commercial scale.

Semi-commercial Work

Each experimental melt was made in a 200-lb. high frequency induction furnace and cast in three "keel" test molds made from green sand. Unless otherwise specified all were subjected to the following heat treatment:

1. Normalizing at 950 deg. C. (1740 deg. F.)
2. Air quenching from 840 deg. C. (1545 deg. F.)
3. Drawing at 650 deg. C. (1200 deg. F.)

Liquid quenching was not used because it is effective with thin-walled articles only. It was found that a repetition of the heat treatment improved the low temperature impact resistance.

The chemical analysis of this steel, as determined by these experiments, should be as follows: C, 0.05 per cent maximum; Si, 0.20 to 0.50 per cent; Mn, 0.50 to 0.80 per cent; S, 0.03 per cent maximum; P, 0.02 per cent maximum; Ni, 3.5 to 4.0 per cent.

The degree of deoxidation and general purity of the metal are highly important. It was proved that a careful treatment of the molten metal bath with basic slag is essential. After the ingot iron and nickel were melted and superheated, lime was introduced to the surface of the molten metal and allowed to become thoroughly mixed with the melt.

At the end of 10 min. the slag was removed and a mixture of burnt lime, spar and ferrosilicon added to the molten metal. This is to facilitate further scavenging of the bath. The electrical power input to the furnace was kept low to allow the slag to completely cover the metal.

After another 10 min. the second slag was removed and ferrosilicon, ferromanganese, and alloying elements (if any) were added to the charge, and the entire melt brought to pouring temperature. Additional small amounts of ferrosilicon and ferromanganese, as well as some aluminum, were placed in the ladle before the furnace was tapped. The metal was poured at a relatively low temperature and during the pouring of each mold small pieces of aluminum were thrown in the ladle.

The minimum physical properties of the straight nickel steel are:

Tensile strength	60,000 lbs. per sq. in.
Yield point	40,000 lbs. per sq. in.
Elongation	35 per cent.
Reduction of area	60 per cent
Charpy impact resistance	at room temperature: 40 ft. lbs. at —115 C., 20 ft. lbs.

It was found that the 3.5-4.0 per cent Ni, 0.05 per cent maximum C steel usually fractured at 60,000 to 65,000 lbs. per sq. in. Attempts to raise the tensile strength proved that the addition of approximately 0.15 per cent V, 0.35 per cent Mo, and 0.50 per cent Cr improved the room temperature tensile strength, although to a certain extent reducing its low temperature impact resistance. However, as this reduction is not necessarily below the minimum value of 20 ft. lb. at —115 deg. C. (—175 deg. F.) it may be tolerated. When nickel and molybdenum are properly balanced, the maximum carbon content may be raised to 0.10 and probably even to 0.15 per cent.

Micro-examination revealed that, generally speaking, the steels most resistant to low temperature embrittlement are those in which carbon is present as spheroidal carbides. The first appearance of pearlite is associated with a drop in low temperature resistance. When in spite of relatively high carbon, the spheroidal state can be preserved, reasonably high impact resistance may be expected.

Nickel and nickel-vanadium steels, irrespective of carbon content, did not have any suppressed transformations and thus did not indicate any potential danger of hardening or embrittlement resulting from rapid cooling, such as after welding. Nickel-molybdenum steel showed a slight suppressed transformation which would prob-

Information supplied by an Industrial Publication

Efficient utilization of recoverable alloys in foundry scrap, which is of vital importance today in foundries making alloy castings, depends primarily on thorough scrap segregation.

The principal factors to be considered in segregation are: positive identification of scrap, adequate storage facilities and constant supervision.

Several methods of sure identification are available. For example, riser shapes can be varied according to composition. Core wires can be inserted in sprues. Molds can be marked to indicate special handling of sprues, gates and risers. Paint of different colors applied after shaking out is a simple, effective method.

Adequate storage space implies first, sufficient room to keep scrap segregated in storage. The amount of space provided should also take into account the ultimate disposition of the scrap. That is, will it be used by the foundry storing it, or be allowed to accumulate before shipment elsewhere?

Proper and continuous supervision is essential to thorough segregation. In fact, it is doubtful if any segregation program will be completely effective unless someone equipped with adequate authority is made directly responsible for maintaining it.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTES FOR THE CUPOLA • FERROMOLYBDENUM FOR THE LADLE

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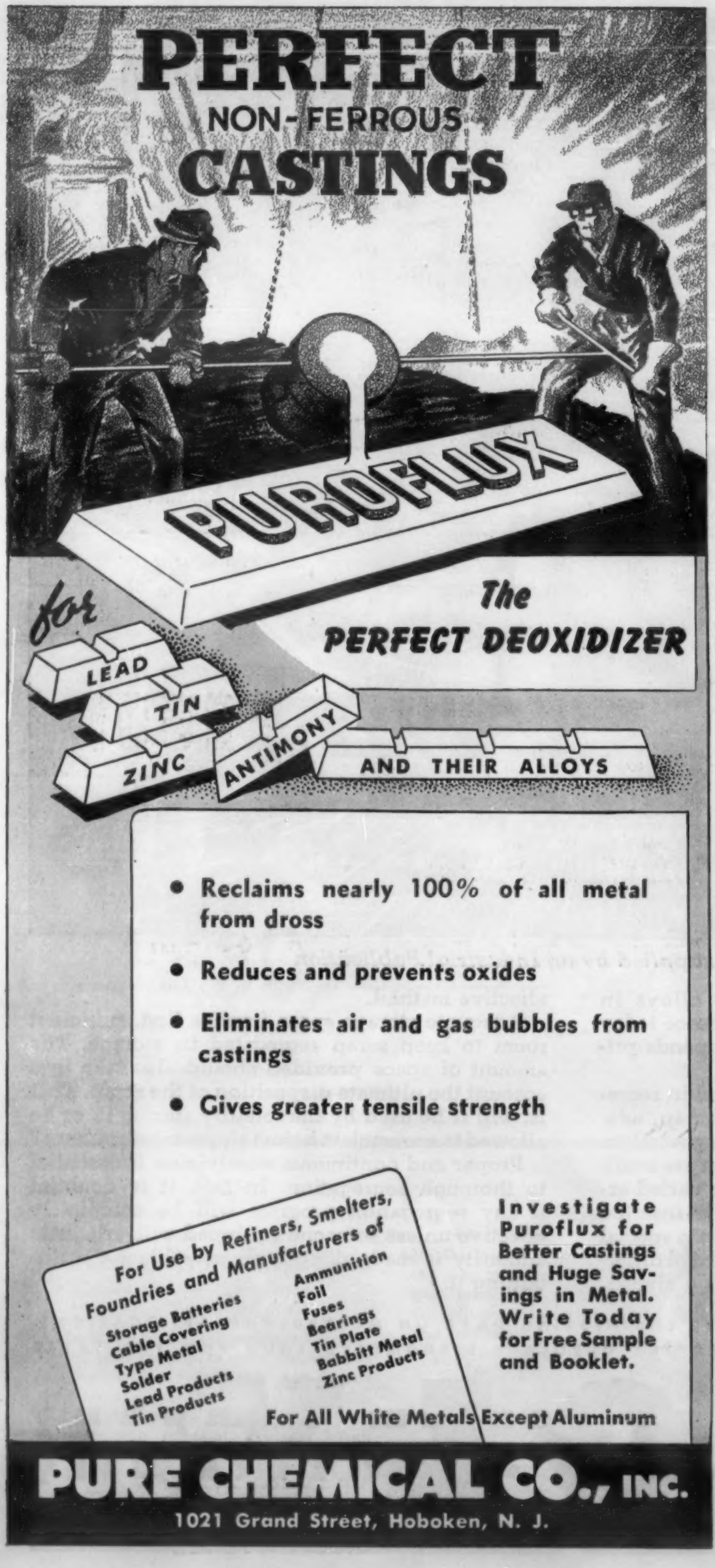
MOLY



ably be intensified by more rapid cooling.

Industrial Experience

In order to prove that these experiments could be reproduced in the shop, four melts were made, using ingot iron as material in two cases and high grade steel punchings in the other two. They were cast into 3-in. flanged valve bodies weighing about 85 lbs. each. Standard tensile and impact test pieces were machined from them and subjected to testing.

These tests showed that the tensile strengths of the "punching" heats were higher than those of the "ingot iron" heats. Yield points, elongations, and reductions of area were nearly the same. The impact resistance of the "ingot iron" at all temperatures was far superior to that of the "punching" heats, although the reason for this is unknown.

A 4-in. flanged valve body, weighing about 265 lbs. was cast from a 600-lb. production high frequency induction furnace using ingot iron as raw material. This was also tested. Results in both cases clearly indicate that industrial castings for applications at temperatures down to —115 deg. C. (—175 deg. F.) can be satisfactorily manufactured.

—N. A. Ziegler & H. W. Northrup. *Trans. Am. Soc. Metals*, Vol. 30, Dec. 1942, pp. 1087-1114.

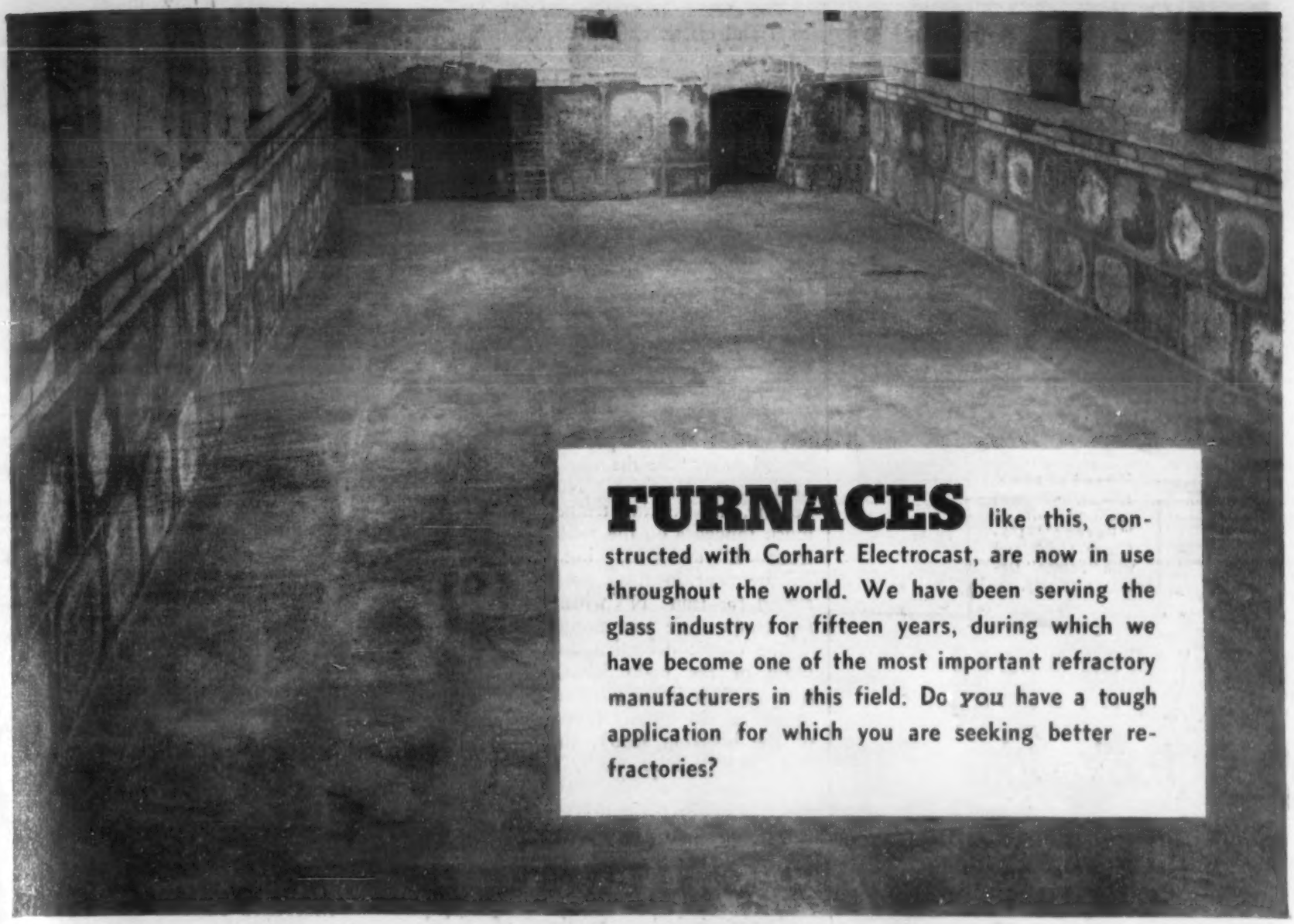
Melting Practice and Properties of Cast Irons

Condensed from "Transactions," American Foundrymen's Association

A knowledge of the elastic properties of cast iron and of the effect thereon of melting practice is important for its use in structural parts. The term "elastic properties" here connotes those complex properties that determine the behavior of cast iron under load and, more specifically, under transverse bending load. The present investigation is an extension to three types of alloy cast iron of a previous study of the elastic properties of three types of plain cast iron. (See METALS AND ALLOYS, Vol. 10, June 1939, p. 360 R/1.)

Transverse test bars 1.2 in. in diameter and 21 in. in length were tested for transverse strength, deflection, Brinell hardness and microstructure. Three types of alloy cast irons were used: Iron "L," a nickel-molybdenum high-silicon iron; Iron "M," a nickel-molybdenum-chromium, low-manganese, medium-silicon iron; and Iron "N," a nickel-molybdenum-chromium, high-manganese, high-silicon iron. The stock pig irons B and C used in a previous investigation were also employed. Iron B was used in making heats of irons M and N, and iron C for heats of iron L.

Each melt was heated to a maximum temperature of 1400 deg. (2550 deg. F.), 1500 deg. (2730 deg. F.), 1600 deg. (2900 deg. F.), or 1700 deg. C. (3100 deg. F.) The bars were vertically cast, bottom poured in green sand molds. Each group of four bars was cast as a unit at a pouring temperature of 100 deg., 150 deg., 200 deg., or 250 deg. C. (200 to 480 deg. F.) above the liquidus temperature of the iron investigated.



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The entire flux walls and bottom of this 16′ x 56′ glass furnace are constructed of Corhart Electrocast blocks.

Now Still Another

Corhart* Uninsulated Bottom!

HERE'S another item to add to your "mental file" on Corhart* Electrocast bottoms.

In March, 1942, a well-known glass manufacturer installed his first uninsulated Corhart Electrocast melting-end bottom. On the strength of its performance, this customer has now installed another uninsulated Corhart bottom in another of his tanks. Both are of 12″ Corhart Standard Electrocast.

But these two tanks are by no means the only ones in which uninsulated Corhart bottoms are now being used.

In addition to numerous insulated bottoms, there are now at least THIRTY - EIGHT uninsulated Corhart bottom installations in glass tanks in North and South America. . . .

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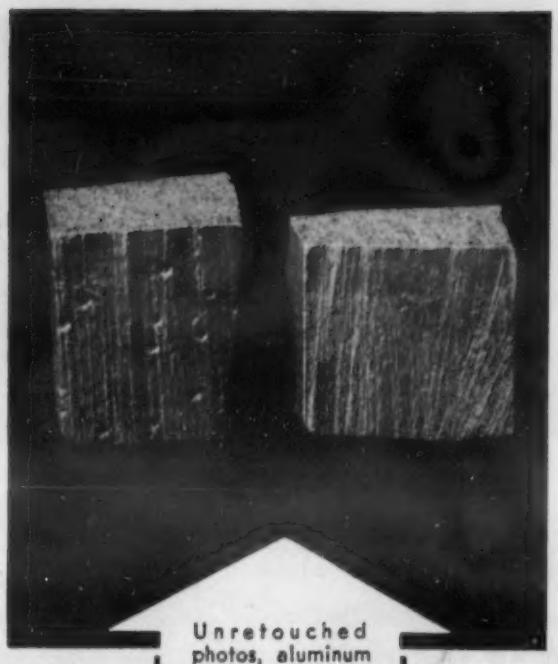

Unretouched photos, aluminum castings: without "Foseco" De-Gaser (left) and with "Foseco" De-Gaser (right).

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You *can't* make sound aluminum castings, billets, slabs, etc., free of porosity, if gases and oxides remain in the melt.

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"Foseco" Degassing evolves inert gases in the liquid metal, eliminates pinhole porosity, increases physical properties, especially elongation. And it's so simple to use, any unskilled person can quickly learn its application. For example, it eliminates the safety precautions required with chlorine, eliminates transportation and storage of cylinders, piping, control instruments.

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The average transverse strength, ultimate total and elastic deflections, resilience and Brinell hardness of irons "M" and "N" were found to be superior to those of iron "L."

Heating and Pouring Temperatures

The maximum heating temperature showed no effect on the transverse strength of irons "L" and "M," but the moduli of rupture of iron "N" were somewhat higher for the two maximum heating temperatures. The highest moduli of elasticity of all the bars tested were obtained with iron "N" at the heating temperature of 1700 deg. C. (3100 deg. F.), but in general no definite relation could be established between the relative moduli of elasticity and maximum heating temperature.

The two lower pouring temperatures tended to increase the strength and relative modulus of elasticity. Neither maximum heating, nor pouring temperatures, exerted much influence on the resilience values for irons "L" and "M," but a considerable improvement in these properties was observed for iron "N" when a lower pouring temperature was employed.

The elastic deflection curves, similar to those of the plain irons, were straight lines in their lower portion, but beginning at a certain point (approximately 3/5 of the breaking load), they inclined toward the deflection axis.

Comparison of alloy irons "L," "M," and "N" with plain irons "A," "B," and "C," indicates that:

(a) Iron "A," showing higher strength, elasticity and resilience values than companion plain irons, possesses strength and resilience equivalent to those of nickel-molybdenum iron.

(b) The relative moduli of elasticity of iron "A" heated to the maximum temperature of 1700 deg. C. (3100 deg. F.) are higher than those of alloy irons.

(c) The beneficial effect of the maximum heating temperature on the moduli of rupture and elasticity was more pronounced for the plain irons than for alloy irons. The effect of pouring temperature for both plain and alloy irons was about the same, i.e., these properties showed a tendency to increase with a decrease in pouring temperature.

(d) The plastic to total resilience ratios of plain iron "B" (a medium cylinder iron) are higher than those of alloy irons.

(e) If the proportion of plastic deflection to the total deflection at fracture is accepted as an index of plasticity of cast iron, an alloy iron "L" may be considered as being the most rigid and plain iron "B" the least rigid.

Graphite Structures

The structure of iron "L" consists of flaky graphite and pearlite. The matrix of irons "M" and "N" appears to be made up of the transition product of austenite, an "acicular" structure.

The graphite of iron "N" shows a tendency to form globules. This was particularly pronounced in the specimen of this iron when heated to the maximum temperature of 1700 deg. C. (3100 deg. F.) and poured at 1350 deg. C. (2460 deg. F.) It is probable that the nodular graphite structure is a contributing factor in obtaining the higher values of the relative modulus of elasticity and Brinell hardness. Some unusual structures of iron "N" were observed.

(a) A patch of an eutectic-like graphite resembling the Widmanstätten pattern. It is believed that this is the result of a controlled rate of cooling, neither extremely slow nor extremely fast, and a eutectic graphite structure consisting of a few very coarse flakes. It is rarely seen in a fully developed form.

(b) The fluffy appearance of the edges of some graphite flakes. This appears because the secondary graphite, which is usually deposited on existing graphite flakes in the form of a smooth band, difficult to show, is here deposited in an irregular manner.

(c) An inclusion, presumably manganese sulphide, of a perfect hexagonal form with the light twinning-like band in the middle. The band is probably a remnant of iron sulphide proper.

(d) Dark lines observed on a graphite flake and crossing it at about a 60 deg. angle. These are thought to be small needle-like crystals formed from secondary graphite. If the flake is in its dark position, the needles appear bright, if in its bright position, dark.

—A. I. Krynitsky & C. M. Saeger, Jr.
Trans. Am. Foundrymen's Assoc.,
Vol. 50, Dec. 1942, pp. 451-489.

Moisture Control for Blast Air

Condensed from "The Iron Age"

An effective method of moisture control in blast air is a chemical system utilizing lithium chloride known as Kathabar.

The amount of moisture that is to be maintained is determined by the product and the physical properties desired in the metal. This will result in saving coke, will eliminate periodic moisture determinations and will improve physical properties. In addition to the reactions which take account of the oxygen content involved, hydrogen is also liberated from the water and of itself this will have far reaching effects upon the physical properties of the metal.

In the Cupola and Blast Furnace

In the metallurgical operations being considered here first (cupola and blast furnace), the chemical constituents of the water are liberated under conditions of extreme reactivity and in direct contact with the iron.

In the blast furnace the moisture enters the furnace with the blast through the tuyeres, reacts with the carbon and liberates hydrogen at the ideal point to be absorbed by the liquid iron which at this point has reached its maximum temperature. Moisture introduced in the solid charge as damp coke or other materials, is driven off at a low temperature with the top gases while the charge is being heated.

The same thing may be said in regard to cupola operation. In the case of the Bessemer, the air blown through the iron provides excellent means for introducing hydrogen into the metal.

Answer to a Foundry Man's Prayer..

How to increase production with *PRESENT* equipment

Today the demand is for more and more production. And with it, the foundry man's problems increase... How to squeeze out additional units!... How to keep up with present schedules, *even!*

In shops and plants all over the country, Truline Binder is helping to show the way!

1. More Cores Per Hour. Because Truline is easy to handle and mix . . . because it produces an easy-flowing core-sand of low, green strength that rams *tight* quickly, it helps save valuable time.

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2. Ends Cleaning Room Bottlenecks. Because Truline burns out quickly, cores collapse completely, making clean-up a relatively simple and easy matter.

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.....

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Operation of a foundry cupola is dependent upon the weather conditions. This requires constant care and supervision to insure satisfactory results. These variations can be met and maintained by the controlled moisture content of the blast and holding it at a definite value. It may be noted that an increase of moisture in the cupola blast will produce greater metal shrinkages and increase the number of cracked castings in the manufacture of malleable castings even though the metal be duplexed subsequent to melting.

Hydrogen and Heat Treatment

There seems to be proof that the presence of moisture in the air used for melting is responsible for the presence of hydrogen in the metal, and that hydrogen retards the rate of annealing of malleable iron.

A patent has been granted to Schwartz on a process for improving the properties and shortening the annealing time of malleable iron by controlling the moisture content of the blast. Analysis of the metal shows that the amount of hydrogen is greatly reduced by reheating, but that its effects are thereby removed does not seem to follow since they persist in the fully annealed iron.

When the use of dry blast was first applied the results were notable, especially a saving in coke and a uniformity of operation.

It has been estimated that in the case of a furnace using 45,000 to 50,000 cu. ft. per min. of air, the removal of each grain of water will mean a little more than 3 tons of water per day.

Data available show an average increase of 16 per cent of iron made and a reduction of 4¼ per cent in coke consumption. This is based on air dried approximately ¾ grain per cu. ft.

Opinion varies as to the advantages of dry blast. Some have maintained that most air will produce satisfactory results. This will give uniform furnace operation but it loses the feature of coke saving and metal increase, and also the increase in hydrogen content of the metal.

Hydrogen is known to have strong influence on the properties of steel at about 400 to 475 deg. F. Flaking of steel is now attributed to the hydrogen dissolved in the metal.

Honda has calculated the pressures involved when hydrogen comes out of solution in a metal cavity. Assuming that the steel just below its solidification point is saturated with 0.0023 per cent hydrogen, the pressure is inconsiderable until 950 deg. F. is reached, heat then rises to about 500,000 lbs. per sq. in. at 500 deg. F. and decreases linearly to nil at about zero. The temperature of maximum pressure coincides with the temperature of flake formation.

Hydrogen has been observed in open-hearth steel. The values seem to run between 0.0003 and 0.001 per cent. This is the usual range although higher values are frequently obtained.

—R. J. Cowan, *Iron Age*, Vol. 150, Nov. 19, 1942, pp. 46-50.

These illustrations from photographs taken by the Rochester Gas and Electric Corp. show crucible furnaces in operation in the Anstice Foundry, Rochester, N. Y. The fuel used is manufactured gas of 537 BTU, using multiple burners. Crucibles are standard, No. 125 long lip. Twelve analyses of copper alloy ingot are melted in addition to four analyses of aluminum, including heat treatable aluminum alloy castings. Melting time is approximately 45 minutes per 375 lbs. high copper alloy.

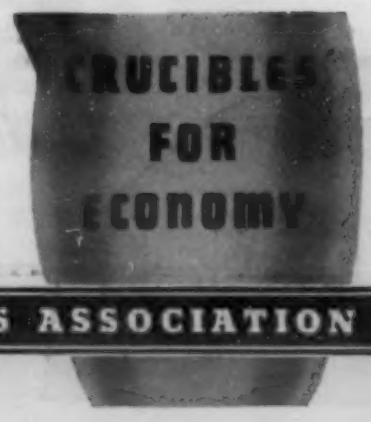
Typical CRUCIBLE FURNACE INSTALLATIONS

With the Nation in an all-out war, foundry management is keenly aware of the value of crucibles for melting nonferrous alloys. Their use insures big production with the necessary flexibility. One of several fuels may be selected depending on your location. Reasons for the use of crucible furnaces include, (1) Clean, gas-free metal can be rapidly produced. (2) The alloy may be changed whenever desired. No absorbed metal remains to contaminate the next melt. (3) Melting cost with crucible furnaces, either stationary or tilting type, is well recognized to be the lowest by far.

When you consider buying nonferrous melting equipment, be sure to consult a crucible furnace manufacturer.

*

No. 1



* *Photos and Data solicited on other Foundries using crucibles*

CRUCIBLE MANUFACTURERS ASSOCIATION

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Casting Trench Mortar Bombs

Condensed from "Foundry"

A trench mortar bomb is a steel casting 9⅝ in. in length, 3 in. in diameter, open at one end, and machined at both ends. A casting a few grams overweight may be salvaged by grinding, but otherwise perfect castings must be produced.

When patterns through continued use are reduced slightly, they are discarded. Corebox es are lined with pieces of thin copper, and when lining shows signs of wear, it is replaced.

The main object is to provide gates and risers to insure homogeneous castings. The second object is to reduce the amount of metal to the lowest point consistent with safety. In the present instance the weight of good shell castings amounts to 52 per cent and shoes 65 per cent of the weight of metal poured in the molds.

Molding sand is used continuously, but the cores are made of new sand bonded with oil and a small amount of cereal binder. Cores are made on a blowing machine and baked in dryer shells. Corebox split on a longitudinal center line and with two core cavities is placed on the table of the core blowing machine and packed with sand. Venting device is one of many ingenious shop kinks and gadgets

—working as a team, they *pack a wallop!*

Boron, used along with another alloying agent — say Molybdenum, — may contribute remarkably to the total beneficial effect. Very small additions of Boron, in combination with Molybdenum, do in fact so improve the physical properties of irons and steels that use of the scarcer alloying element can be reduced. And while available supplies of Molybdenum are thus made to go further, exacting specifications are satisfactorily met, throughout a wide range.

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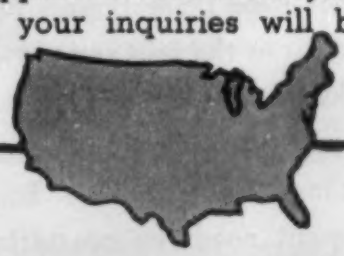

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installed to facilitate production.

Since cores are supported in dryer shells while in the green state, and later are placed in molds in a vertical position, no rod, wire or other form of reinforcement is necessary. After cores are dried they are dipped in a silica wash which imparts a uniform coating. Print end of the core is slightly tapered and slightly over size as compared with the print in the bottom of the mold.

In addition to the main core, a small ring core is set in each mold at the drag joint. At this point a narrow band is machined on the castings. Flasks are rectangular steel castings rounded at the corners and provided with vents.

The metal is poured through a central sprue which extends a short distance in the drag to form a well. From the well, metal rises through a core right and left and enters chambers in the cope from which it is conducted into each group of four mold cavities. The chamber serves as dirt catcher and feeder. Metal from bull ladle is poured over the lip. Steel is poured at 2800 deg. F.

While still red the castings are shaken out at the end of the conveyor line. If gates are broken while the casting is hot, it will either break in or leave a stump. Gates should be removed when the casting is cold. Risers are removed under a shear, and must be heated to about 400 deg. F. to insure clean cut. After leaving the shears, the cycle includes tumbling, grinding, hydraulic test at 1000 lb., annealing for 2 hr. at 1600 deg. F., and inspection for size, weight, porosity, etc.

Manganese steel used for these castings must conform to exacting specifications.

—Pat Dwyer, *Foundry*, Vol. 71, Jan. 1943, pp. 66-69, 151-152.

Ladle Treatments for Iron

Condensed from "Foundry Trade Journal"

In soft iron production an appropriate addition of powdered silicon or ferrosilicon to the molten metal in the ladle provides an easy means of reducing combined carbon. For purely graphitizing purposes other substances are available. Ladle additions of calcium silicide have probably been tried by most foundrymen (about 0.4% is required) but according to the personal experience of the author it did not show any advantage over crushed ferrosilicon and was decidedly more expensive.

Inoculation by Carbon Efficacious

Recently, Braidwood has proved that inoculation by carbon is quite efficacious. He experimented with both crushed and lump electrodes added to the ladle and showed that it eliminates all "lacy, reticular" graphite or dendritic graphite from the castings, giving random flakes or medium sized graphite. Manganese ladle additions are easily carried out in the same way as ferrosilicon.

Whether a ferrosilicon-manganese alloy will act as an inoculating agent or not depends on its composition. The carbon-free 40:40:20 alloy with 40 per cent Mn and 40 per cent Si definitely inoculates, but the 70 to 75 per cent manganese alloy did not appear to function in this way. In the author's experience, chromium was far the worst of all the ferroalloys with which to make ladle additions.

All grades of ferrochrome from the carbon-free to the 4 to 6 per cent C alloy acted as deoxidizing agent, and a little chromium was always lost by this reaction. Therefore, the author avoided ladle additions of chromium whenever possible and, if the quantity of chrome iron be not too small, he preferred to use either chromium briquettes or chromium pig-iron in the cupola charge.

The author preferred to charge nickel into the cupola in the form of ingots when making inoculated irons such as Ni-Tensyl.

The Two-Cupola Process

In discussing this paper J. L. Francis pointed out that H. H. Judson commenced using the two-cupola process for the production of pressure resisting gray-iron castings in U. S. A. as far back as 1926. As the title implies, it was necessary to have two cupolas melting simultaneously, one running a white or graphite free iron, while the other produced a soft iron. Additions of the soft iron were made to the hard iron in the ladle.

The mechanical properties of the iron produced by this means were superior

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to those of a material of the same analysis run from charges melted in a single cupola. It appears that the superiority of the two cupola cast iron is analogous to that made from high percentage steel scrap charges plus ferroalloy additions, melted in a single cupola to which late ladle additions of ferrosilicon, nickel-silicon, or calcium-silicide in a finely divided form were made.

With the two-cupola process, the metal from the hard iron cupola was produced from graphite-free charge materials, such as steel scrap or white iron. The addition of the soft iron was equivalent to an innoculant, and as such should be added immediately prior to pouring the casting, so that the minimum of time was available in which the precipitated graphite could coarsen.

Product of the Two Cupola Process

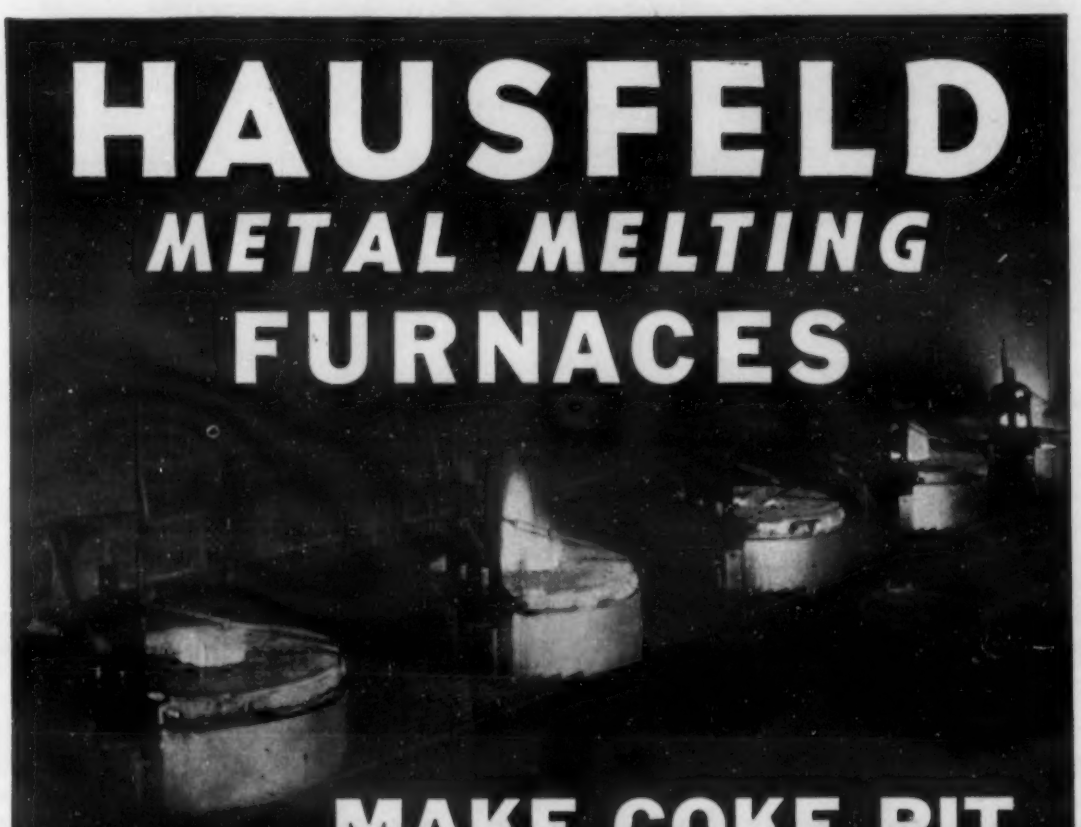
Cast iron manufactured by the two-cupola process could also be compared with that resulting from an extended superheating treatment whereby the molten iron was raised to above 1600 deg. C. (2912 deg. F.) in an electric furnace and maintained at this temperature long enough for the large graphite flakes partially to dissolve. For ladle additions to be made successfully, it is obvious that the metal must be tapped from the furnace as hot as possible.

Low-carbon irons of the high-duty type showed a tendency towards the formation of fine under-cooled graphite or, as it was alternatively known, grain boundary or reticulated graphite. When present in the structure in this form, the impact strength of the material was much less than when the graphite was present in the normal random flake distribution. To prevent the formation of reticulated graphite, sufficient nuclei must be present in the melt to induce graphitization to commence from the molten condition. Such irons froze in the stable iron-graphite system and exhibited random graphite formation. Irons of low total carbon which solidified in the metastable iron-carbide system, as white irons, deposited graphite after solidification as a result of the breaking up of the eutectic carbide; this graphite was fine and in a dendritic pattern.

—J. H. Williams, *Foundry Trade J.*, Vol. 68, Dec. 17, 1942, pp. 345-349.

HAUSFELD

METAL MELTING FURNACES



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The battery of Hausfeld stationary type Crucible furnaces shown above is one of many recently made in brass foundries formerly operating coke pit furnaces.

Burning gas or oil, each furnace is a self-contained, independent unit, individually controlled by its own motor and blower. Each furnace may be used for melting a different mix, brass, bronze or other copper alloy. All furnaces may be operated at once, or any one may be shut off at will, with immediate saving of fuel.

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Unusual Foundry War Problems

Condensed from "Foundry Trade Journal"

The most suitable woods for patterns are pinus-strobus or Canadian yellow pine, and African or Honduras mahogany for better class patterns and hard use. The shrinkage ratio of these woods, being very low, is greatly in their favor, and patterns properly constructed give very little trouble with regard to this and warping. Metal patterns seem to have become part of the trade.

Tank track castings in manganese steel have been one of the greatest tests ever expected of foundry or patternshop. Thousands of track links have been produced by means of metal patterns. No machining operations are carried out on these castings, and when castings from different foundries are mixed together, they must assemble within predetermined limits of plus or minus 1/16 in., 10 to 12 links even on the largest type of track.

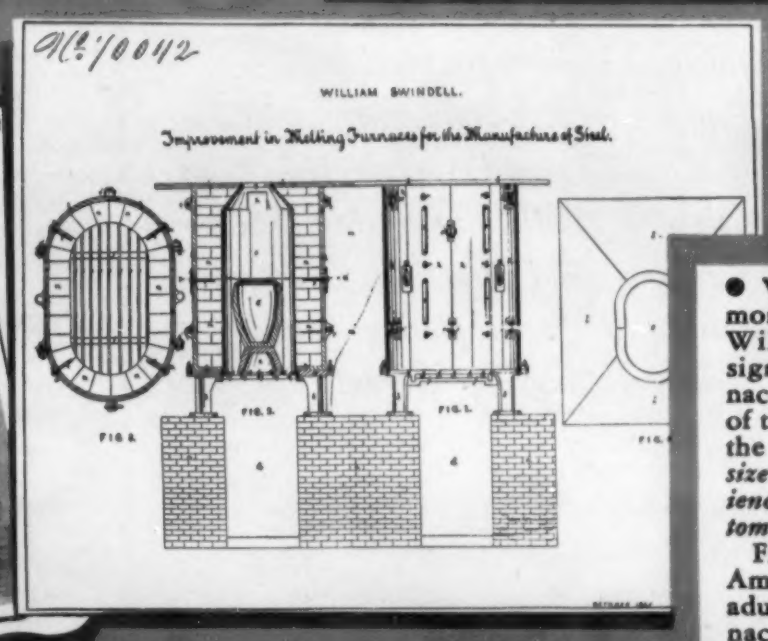
This example illustrates that the patternshops are keeping up with the present rate of progress. The author had been selected to face the problem of interchangeable patterns, core-drying equipment and a special type of corebox, etc., for quantity production. One pattern recently returned for alteration had produced 200,000 castings.

The author expresses the opinion that the best material for the production of metal patterns was cast iron, and lacking this material, aluminum D.T. 424 or a brass alloy, containing 70 Cu, 27 Zn, 2 Sn and 1 per cent Pb. The author regretted that he had not been able to do the experimental work on aluminum coreboxes as was the case in ordinary times.

One very large firm had all aluminum coreboxes for use with blowing machines, which were painted a bright red. Patternmakers daily examined the corebox paint, and any part which was worn showed up the metallic surface. Such parts were then renewed in steel. This method was as cheap and satisfactory as making them in cast iron.

—Wilfred C. Perry, *Foundry Trade J.*, Vol. 68, Dec. 31, 1942, pp. 381-384.

Over 90 YEARS OF KNOWING HOW



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Aircraft Dies Made of Plastics

Condensed from "American Machinist"

The aviation industry has sponsored the use of dies of many materials other than steel. Forming and bending dies made of plastic and semi-plastic materials can be used on a large percentage of sheet metal aircraft parts, especially those made of aluminum or magnesium alloys.

In view of the critical shortage of steel and other metal die materials, the use of such non-metallic die materials is of particular interest at the present time. Furthermore, these dies can be made in less time than steel dies and operations can often be carried out on high speed wood working machines thus relieving the load on metal working machines.

While the durability of plastic dies is not as great as that of steel dies, it is often longer than needed due to the rapid obsolescence of aircraft designs. Another advantage is the fact that these dies protect the pure aluminum coating on sheet aluminum alloys better than do steel dies.

The Naval Aircraft Factory has made an important development in the use of these materials for construction of blanking and forming dies by manufacturing mating dies for use in single action mechanical presses as well as hydraulic presses. In addition, these die materials are employed for the forming, blanking, and combination blank-and-form dies for hydro-press operations with rubber platens.

Ordinarily no facing material is needed for Masonite semi-plastic dies if the production required is under 500 pieces. A facing, ⅜ in. thick, of Bakelite is generally used where about 2000 pieces are to be made and the die wear must be held to a minimum. Larger production requires ⅛ to ¼ in. thick steel facings (highly polished and usually hard chromium plated, especially where Alclad is to be formed).

Design details of a modification of these dies (Schlenzig type) are discussed. All parts except steel springs, pins and machine screws and rubber mountings are constructed from semi-plastic materials.

—B. Schlenzig, *American Machinist*, Vol. 86, Nov. 12, 1942. pp. 1307-1314.

Cast-to-Form Die-Casting Dies

Condensed from "Foundry Trade Journal"

In die-casting, and to a less extent in drawing, forming and forging, cast-to-form dies have been used with considerable success and have reduced tooling-up time and outlay. In order to show a saving over other production processes, die-casting requires that, in general, large orders be placed for individual components.

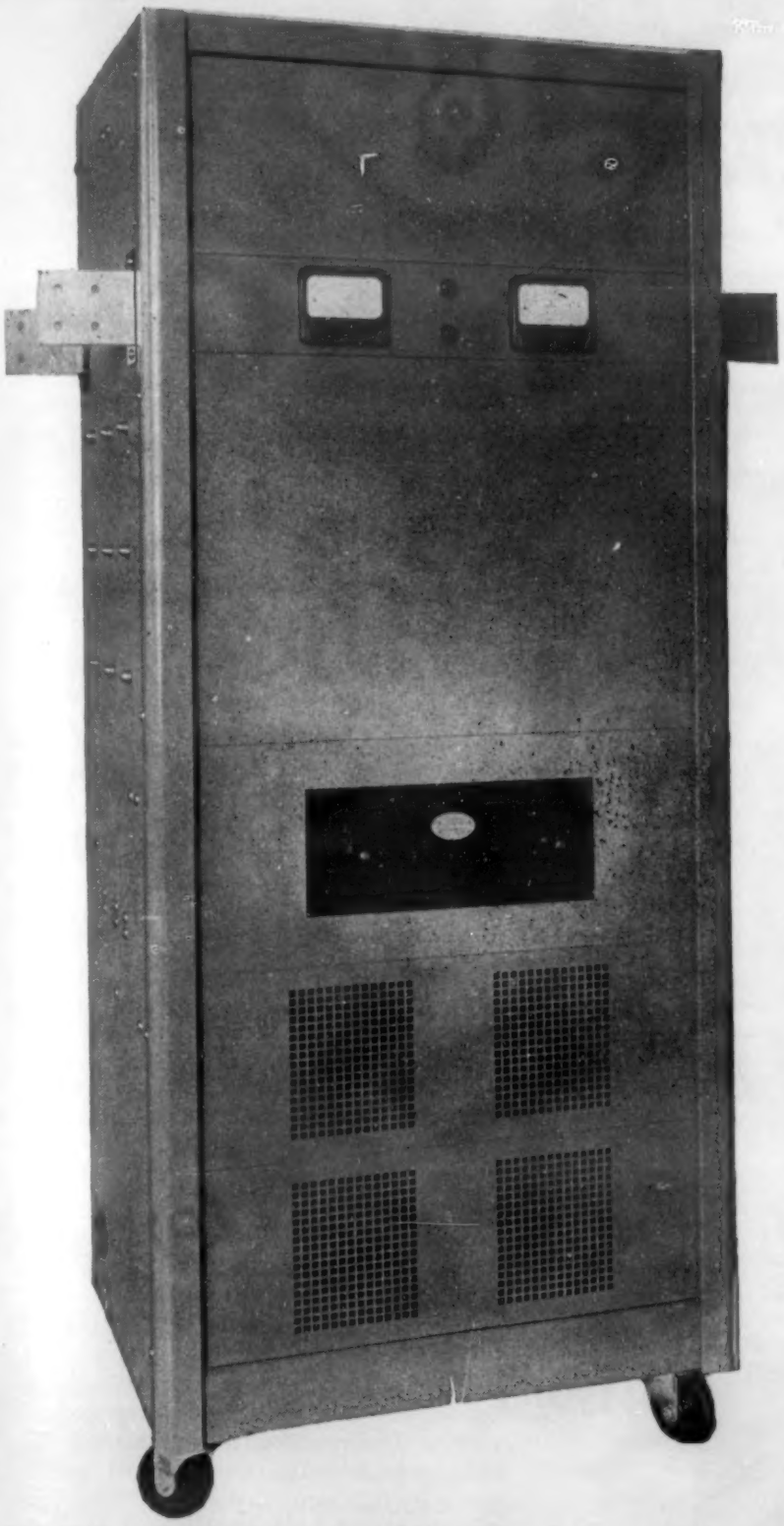
Die design in the United States was influenced considerably by the use of three-dimensional milling machines such as the Keller to rough out cavities, and to have skilled craftsmen finishing by hand. This, however, requires extreme skill.

Some firms, known to the author, were experimenting with cast-to-form dies as early as 1933, particularly in the field of ornamental hardware. Many such dies were put into commission, but the difficulty of getting a good finish on the cast iron, and the likelihood of localized porosity appearing during the finishing process, limited their successful applications to a few special cases only.

Common gray iron tended also to break down at sharp edges where ejectors and cores came to surface of the die, and was subject to selective erosion in the vicinity of the sprue-hole. The use of inoculated alloy irons removed the purely material difficulties, and made it possible to produce cast-to-form dies, which were susceptible of heat treatment, close-grained, and very resistant to corrosion. The major problem remaining was the satisfactory finishing of the cavity surface.

In the finishing of steel dies, hand-chipping and filing have been superseded by the

re: CONSERVATION



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Total floor space required only 6 square feet—a saving of up to **95%** in working space. No additional space is needed for auxiliary equipment.

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Mobile unit—**roll** into place. No special foundations or framework, no riggers. Shift to new location quickly at any time.

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Starting equipment, voltage controls, protective devices, supervisory lamps, meters—**all** in one cabinet. Simply connect to power supply and tanks—and it is ready to produce.

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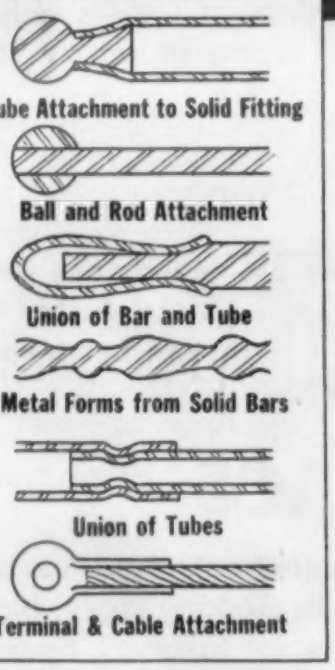
Tube Attachment to Solid Fitting
Ball and Rod Attachment
Union of Bar and Tube
Metal Forms from Solid Bars
Union of Tubes
Terminal & Cable Attachment

In one operation, this machine connects tubing or cables to solid fittings, or forms metal sections from solid bars without cutting. A feature of its design is the use of hydraulically-operated wedges to compress the dies so that swaging force is applied at right angles to the work . . . not obliquely as with tapered dies. In reducing outside diameter of tubing, therefore, tendency toward elongation is lessened and thickness of tubing wall is increased. Fittings having large ends can be put into machine without removing dies. This machine simplifies handling of many other operations which previously required more complex, time-consuming methods.

Further information on request.

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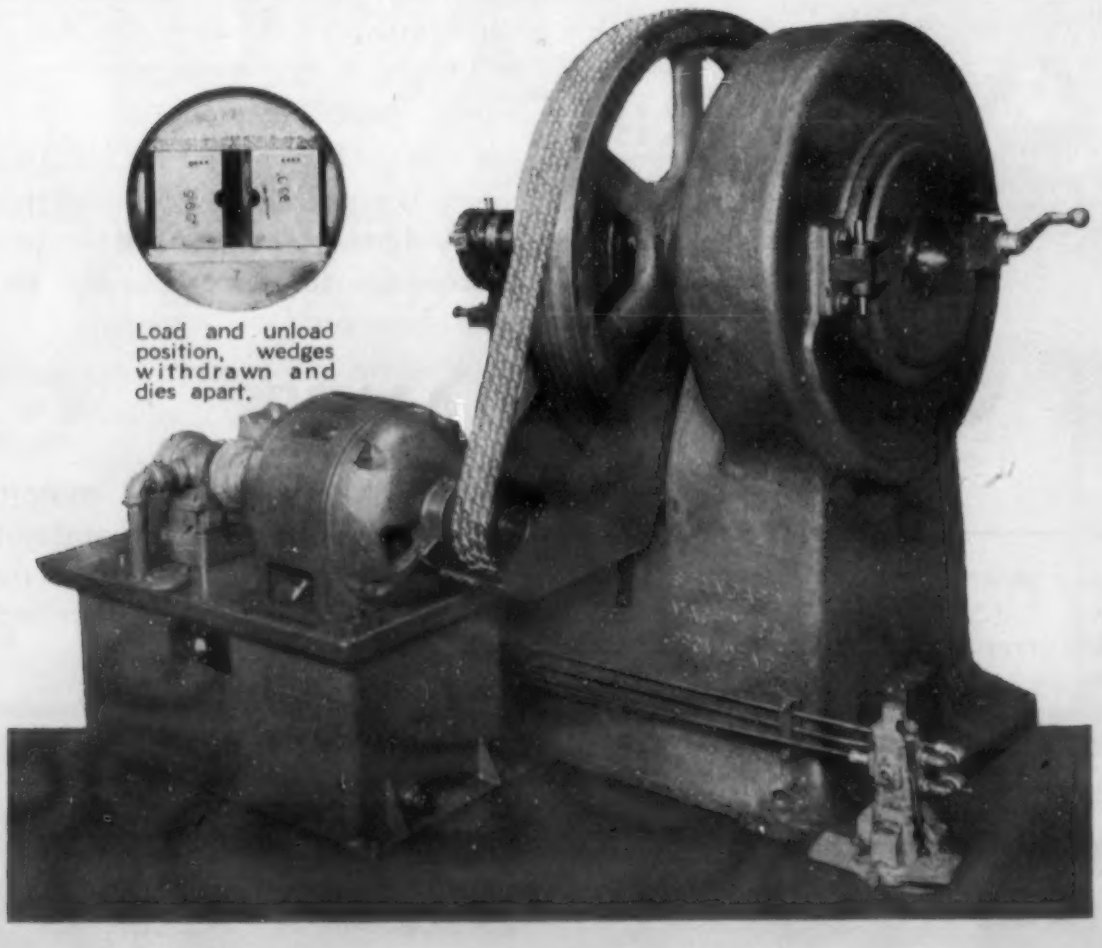

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use of high-speed pneumatic chippers and filers, operating at 500 to 6000 strokes per min., and small manually-directed pneumatic grinders which developed up to a mile-a-minute surface speed on a ½-in. diam. grinding wheel. Such tools were found to be satisfactory on cast dies also. Where such dies are cast of a suitable alloy iron (such as Meehanite) thin cavity sections, which it would be inadvisable to core, can be milled out on the die without the likelihood of encountering porosity.

Dies made in one piece, whether steel or alloy iron, have in general a longer life than those built up of separate inserts, and in the case of the higher melting-point alloys, the alloy iron may be more satisfactory. Where samples of the components to be cast are available, the dies may be cast from plaster patterns.

—H. K. Barton, *Foundry Trade J.*, Vol. 68, Dec. 24, 1942, pp. 367-368.

Water-Cooled Resistance Welding

Condensed from "Steel"

A modification of the standard resistance welding process is used to make stranded cable connections and other small parts for electrical products. It consists essentially of welding by means of special tips and having a stream of water, at a rate sufficient to keep the work cool and prevent oxidation at the weld, play on the stranded wire close to the electrode during the operation.

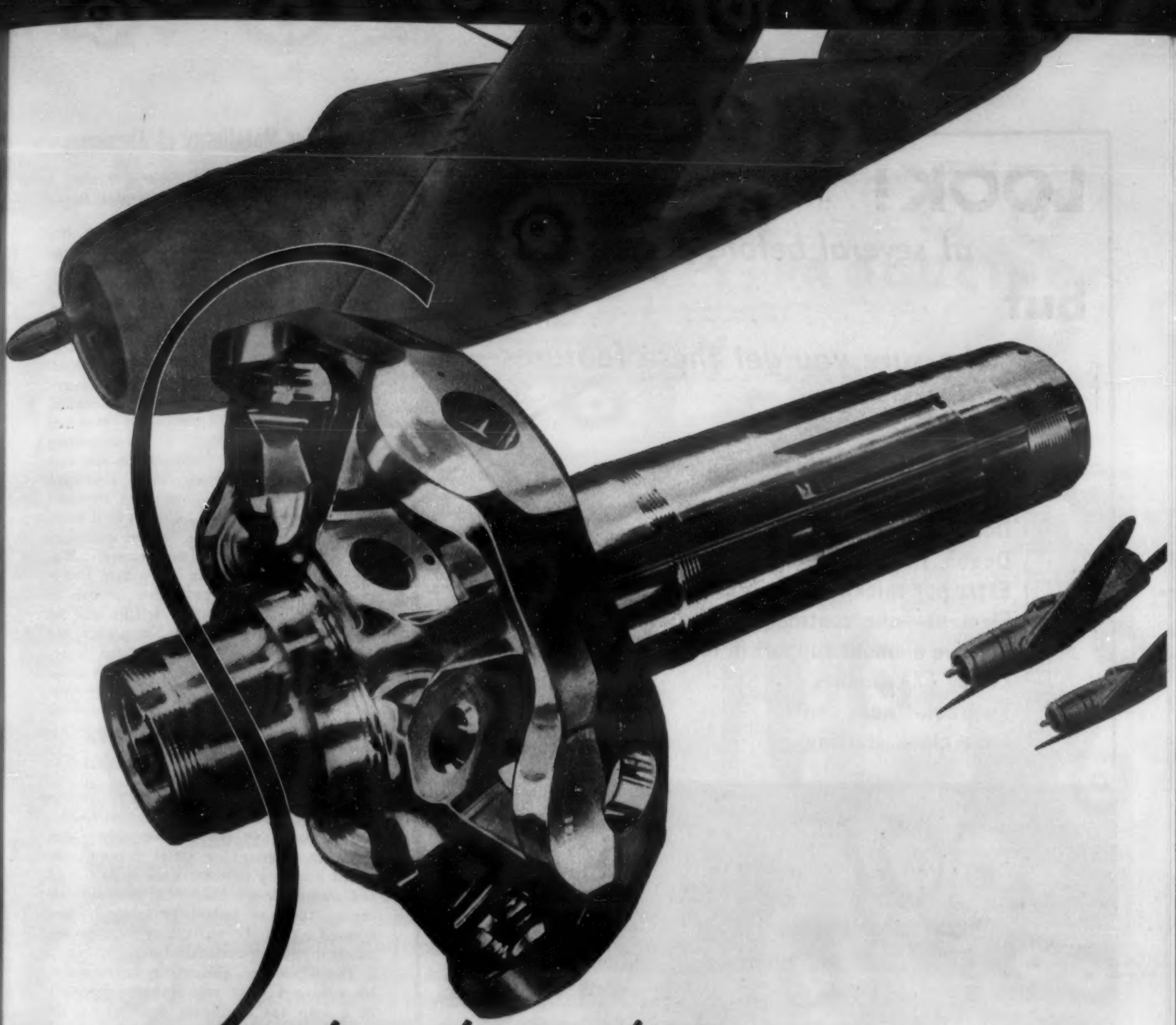
Machines are usually designed with one fixed and one movable electrode with a special jig fastened around the stationary terminal to hold the parts firmly in their relative positions for welding. Cooling the electrodes by mounting them in water-cooled holders increases tip life. A Cupaloy tip with a molybdenum insert is most satisfactory for welds requiring no flux. Carbon tips are required where flux is used. Inserts that contact the wires are grooved to prevent flattening the cable.

After the parts have been inserted in place in the lower electrode jig, lowering of the upper electrode is initiated by pressing a foot-pedal. The welding cycle is completed automatically, once started. The welding-machine is air operated and is timed by electronic controls. The completed assembly may be removed from the jig immediately without use of pliers or gloves.

This process has replaced hand operation, decreasing cost of production and greatly improving the quality of the parts. The wire cables thus made remain flexible to the point of weld. In soldering or brazing, the molten metal cools rapidly after being drawn into the hot cable by capillary action. The resulting rapid quench makes the cable connections much stiffer and more brittle.

Cooling the parts with water not only makes handling easier but the welding heat is prevented from running into areas adjoining the weld. Thus the original properties of the individual parts are not changed, and maximum flexibility of the copper cables is retained.

—J. A. Merryman, *Steel*, Vol. 112, Jan. 25, 1943, pp. 56, 61.



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A leading automobile manufacturer now making Pratt & Whitney aircraft engines had done a remarkable job of mechanical production . . . and was interested in stepping up the efficiency of the metal cleaning (chemical) operations.

A wide variety of steel and brass engine parts—including the polished steel propeller shaft illustrated—had to be cleaned of mineral cutting oil, black emery, or tallow polishing compound, prior to tin or cadmium plating . . . All work went through a solvent degreasing operation. Electro-cleaning, with two kinds of cleaners, was carried on in two crane operated tanks, with both direct and reverse current. But even with this cycle, cleaning of polishing compound was not complete.

A Penn Salt technical representative was able to do a real job of improving this method. He eliminated the solvent degreaser—and with the same Pennsalt Cleaner in each tank, he used it as both a soak-cleaner and electro-cleaner.

The resulting work was excellent. There were no rejects. The finish was judged to be the brightest ever obtained. Moreover, everybody in the plating room welcomed the elimination of the costly solvent degreasing operation.

What's *your* metal cleaning problem? Whatever the kind of metal or the type of material to be removed, you can benefit by the experienced advice of a Penn Salt technician. Let him tell you what the family of Pennsalt Cleaners is doing throughout industry today to save time, materials and labor. If you prefer, write fully to our Pennsalt Cleaner Division, Dept. MA.

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Powder Metallurgy of Aluminum

Condensed from a paper for the Am. Inst. of Mining & Metallurgical Engrs.

Aluminum powder has not been employed extensively in powder metallurgy for three reasons; (1) It oxidizes readily, forming a film of highly refractory oxide that has been considered likely to interfere in powder metallurgical work; (2) during compression, aluminum and aluminum-alloy powders tend to adhere or cold-weld to the die walls; (3) aluminum-alloy powders are harder than elemental aluminum. Some (particularly atomized powders) are susceptible to age-hardening.

Atomization was found to be the best method of making elemental aluminum powders. Molten aluminum was atomized in a current of hot gas, followed by a quick chilling of the spray in large quantities of air at atmospheric temperature. The powder is coated by an oxide film, but it is thin and highly protective because of the smooth surface of the particles and the rapid quench. This film has proved not entirely objectionable and sometimes of actual value, particularly in controlling grain size in the finished articles. This method is flexible, can produce a wide range of particle sizes, and is adapted to safe, large-scale and economical production.

Lubrication of Dies

Cold-welding prevents quality production with close tolerances and high strengths. To overcome this, the dies were lined with flat-lying, overlapping metal flakes of so-called bronzing powders used in paint and ink manufacture. Suspended in a volatile carrier such as carbon tetrachloride and sprayed on the die walls, they form a thin, substantially impenetrable layer.

The lubrication quality may be improved by adding a fatty acid (as stearic acid) or a soap (as aluminum stearate) to the carrier. The lubricant may also be painted on the die wall or applied with an automatic wiper, preferably after each piece is ejected. Use of this lubricant reduced the pressure required for ejection as much as 95 per cent, and prevented lamination. The compacts produced were strong, clean, and to close tolerance.

Use of Alloy Powders

Specimens produced by compression and sintering of alloy powders were found to be inferior to analogous wrought or cast material, seriously lacking ductility. However, several grades of atomized elemental aluminum powders compacted at high pressures, produced specimens with properties approaching those of wrought annealed commercial aluminum.

It was found that by mixing alloying elements in powder form with elemental aluminum powder, the requisite alloys were formed during the sintering operation. Powders screened through different meshes were compressed at various pressures and heat-treated.

All specimens were sintered for 30 min. at 620 deg. C. (1150 deg. F.) in air. In addition to this, the furnace time included a 15-min. heat-up and a 15-min. cooling period, permitting the temperature to drop to 510 deg. C. (950 deg. F.). At this point the specimens were quenched

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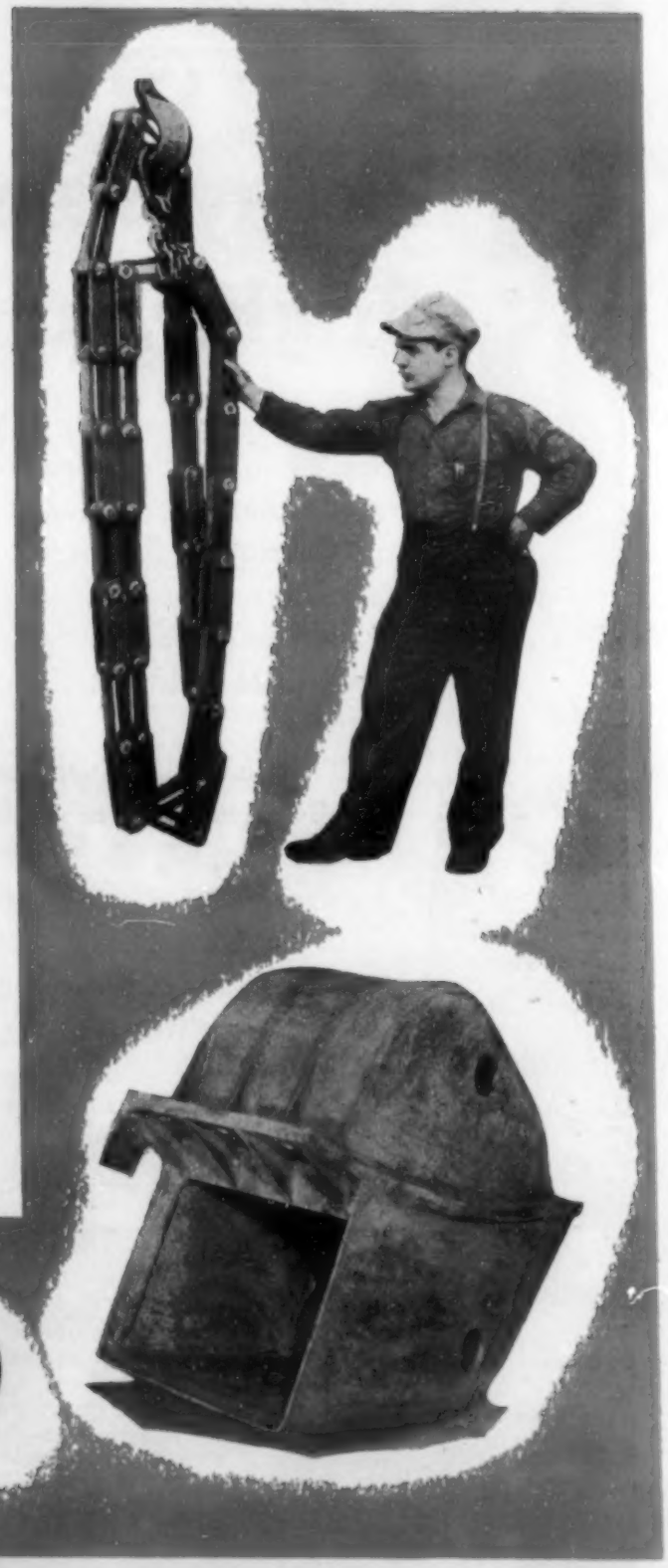

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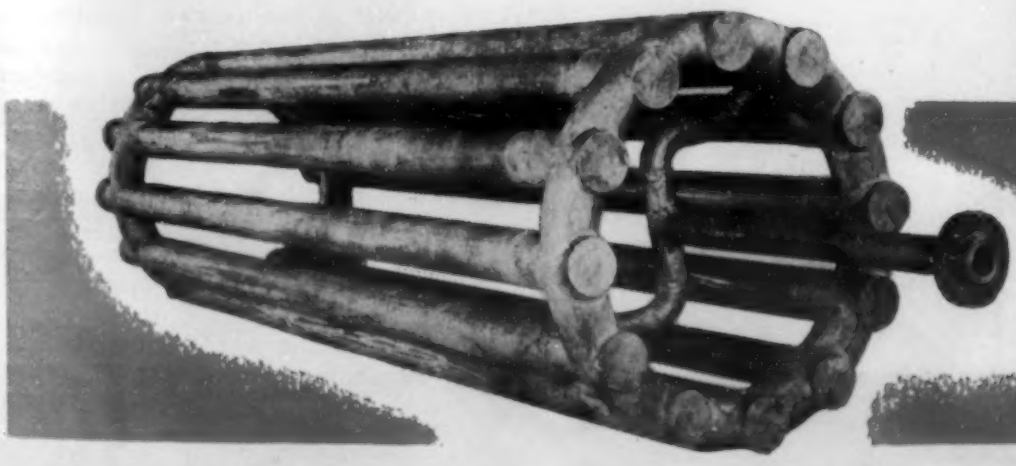

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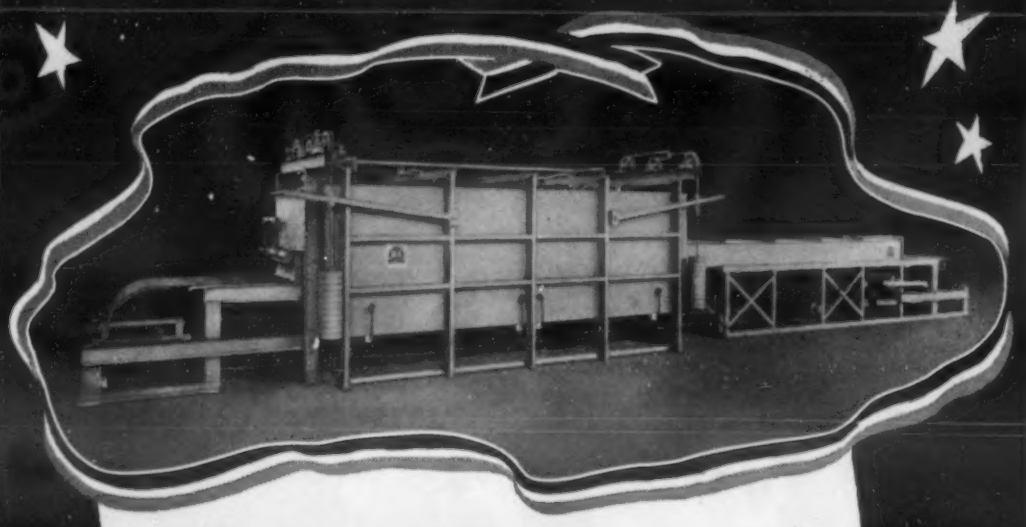

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in cold water. Results indicated that particle size has slight effect on tensile strength. However, fine powders have poor flow characteristics; abrade the die, and tend to be forced between the die wall and the punch forming fins.

Adequate commercial results can be obtained with compacting pressures between 40 and 60 tons per sq. in. At 60 tons per sq. in. the tensile strength obtained was 17,500 lbs. per sq. in., with an elongation of 30 per cent in 1 in.; values not far short of those of forged aluminum. Pieces compressed at 50 tons per sq. in. showed a fatigue resistance of approximately 8000 lbs. per sq. in. with 108 cycles of stress without rupture.

Alloy Properties

When aluminum powder of at least minus 11-mesh was used, the foregoing conclusions held true for 96-4 aluminum-copper; 95-4-0.5-0.5 aluminum - copper-magnesium - manganese and 97.2-2.5-0.3 aluminum - copper - magnesium. In tests made with sintered compacts containing 4 per cent of electrolytic copper, the best tensile strengths were obtained by sintering in hydrogen.

With a high compacting pressure of 50 tons per sq. in., nitrogen and air are almost equally effective. At high compacting pressures, the best ductility was obtained in nitrogen although it was good in both nitrogen and air. At low pressures, both nitrogen and hydrogen are superior to air.

Higher densities were obtained with low compacting pressures, but the specimens warped during sintering in hydrogen at 600 deg. C. (1100 deg. F.), a temperature necessary for adequate diffusion of the mixture. Cooling to 500 deg. C. (930 deg. F.) before quenching minimizes warping. A conventional precipitation - hardening treatment raised the hardness of the material to 50 Rockwell B.

After solution treatment the material has a tensile strength of 38,000 lbs. per sq. in. and elongation of 10 per cent as compared with 33,000 lbs. per sq. in. and elongation of 4 per cent for cast solution-treated material. Pieces are substantially free from large blowholes and inclusions.

In further experiments, 0.5 per cent each of finely divided manganese and magnesium was incorporated in the 96-4 aluminum-copper mix to produce a high-strength material having some of the properties of duralumin. A brittle 50-50 aluminum-magnesium alloy was pulverized and gave better results than any elemental magnesium powder obtained. In this case air sintering did not give optimum results.

The best results were obtained by sintering in nitrogen at 580 deg. C. (1075 deg. F.), cooling to 510 deg. C. (950 deg. F.) and quenching in cold water, which leaves the material susceptible to age-hardening at room temperature. The compacts had initially a tensile strength of 33,000 lbs. per sq. in. and an elongation of 10 per cent. Room-temperature aging treatment for 4 days raised the tensile strength to 50,000 lbs. per sq. in.

A limited amount of experimental work has been done recently with a modified aluminum-alloy composition mixture containing 2.5 per cent Cu, 0.5 per cent Mg, balance aluminum. Elongation of 20 per

FIRTHITE SHOWS HOW..

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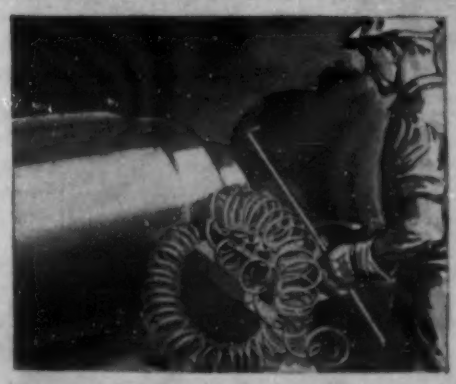
CHIP CONTROL. The rapid machining of **alloy steel** requires effective means of controlling chips. Long, hot, tough chips endanger the operator, make chip disposal difficult, reduce the value of scrap (by $2.00 a ton), cause tool breakage, and delay work.

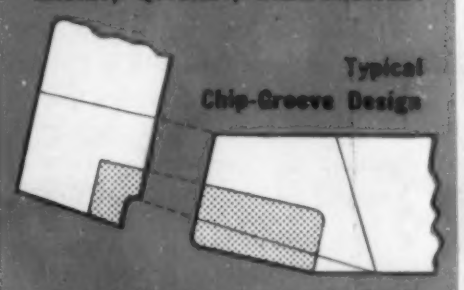
The remedy is properly designed chip breakers. Tools with chip breakers require a little more power but, where long chips are a problem, chip breakers are the answer.

Aside from the safety factor, chips that can be **shovelled** are readily marketable as scrap, command a higher sale price per ton, and—most important to the war effort—speed the **recovery** of scarce and critical alloys.



NO CONTROL without Chip Breaker OR CHIP CONTROL with Chip Breaker

HOW TO GRIND A CHIP BREAKER EASILY, QUICKLY, INEXPENSIVELY



A quick, simple method of designing and grinding chip breakers, as illustrated, is described on pages 41 to 43 of the FIRTHITE Users' Handbook...or a FIRTHITE Engineer will gladly discuss chip control in your plant.

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① ② ③

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2. AFTER HEAT-TREAT
3. PREPARATORY TO METALLIZING

● TRADE journals have been featuring write-ups on the deep finned aluminum alloy cylinder heads for airplanes. Directives have ordered double the original tremendous production of bombers, pursuit, transport and other airplanes for immediate battle requirements. The needed number of cylinder heads jumped to astronomical figures.

Pangborn broke the impending bottleneck to this almost impossible production schedule by designing—and delivering—eight ROTOBLAST Airless Tables and twelve special semi-automatic Air Blast Machines for handling this great volume of cleaning. More are now being built.

The ROTOBLAST Tables are used for the first two cleaning operations. As they come from the shakeout the inside and outside surfaces of the cylinders are table cleaned to remove all sand. The units are again ROTOBLASTED to remove scale after heat-treating.

The final blast cleaning is done in special Pangborn Air Blast Machines. This treatment removes all grinding marks—and prepares a perfect surface for exterior metallizing.

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cent with tensile strength on the order of 40,000 lbs. per sq. in. were obtained with compacting pressures as low as 30 tons per sq. in., the sintering being conducted in nitrogen at 600 deg. C. (1100 deg. F.) for 30 min.

Further advantages of this new technique are economy of materials, low scrap loss and low cost of operation.

—G. D. Cremer & J. J. Cordiano. *Preprint, Am. Inst. Mining & Met. Engrs.* T.P. No. 1574, Feb. 1943 meeting, 11 pp.

Aircraft Joining Methods Compared

Condensed from "The Welding Journal"

This paper reports the results of fatigue investigation on gas- and arc-welded composite structures and joints. The data are issued as a progress report, and are not intended to offer general conclusions but rather to indicate the desirability, methods and projected results obtainable.

Various types of joint were tested as fatigue specimens of welded and copper-brazed tubing of X4130 and bar stock of 4340 and 4640 grades of steel. The results of fatigue tests are tabulated for the various specimens and locations of fatigue cracks are shown in a diagram. In general the fusion welds broke at the edge of the weld and the copper-brazed joints failed in the brazing alloy.

Fatigue tests of the welded X4130 tube-triangles gave an endurance limit of less than 9000 lbs. per sq. in. or less than one-half of that obtained by other investigators for butt-welded joints.

The endurance limit of tubular joints from X4130 aircraft tubing which were heat treated in a regular atmosphere after copper brazing was 16,000 lbs. per sq. in. If heat treatment was done in a special atmosphere it is believed that this fatigue limit could be improved because of the elimination of a decarburized surface found on the specimens investigated here.

The endurance limit of built-up crank journals, copper-brazed and then treated was much less than one-half of that obtained on one-piece journals. None of the copper-brazed joints was completely brazed over the entire mating surface and if the entire area was properly brazed it is believed that the endurance limit could be considerably increased.

Fatigue tests on one airplane engine motor mount gave failure in one of the tubular members 10 in. away from a welded joint and at a location where an electric arc was accidentally struck on the tube. Indications are that the fatigue limit of the tube is decreased by more than 79 per cent by the presence of the arc spot. Also, on the basis of one million stress reversals and the complete motor mount showed higher endurance limit values for the welded joints than obtained on tube-triangles.

It is believed that further tests of both structures under equal welding conditions will permit using the easily determined fatigue limit of the tube-triangle as an index of the fatigue limit of the complete mount.

—T. V. Buckwalter & O. J. Horger, *Welding J.*, N. Y., Vol. 21, Nov. 1942, pp. 525s-539s.

HEAT TREATING *for* STRESS RELIEVING *of* FUSION WELDED PRESSURE VESSELS *with*

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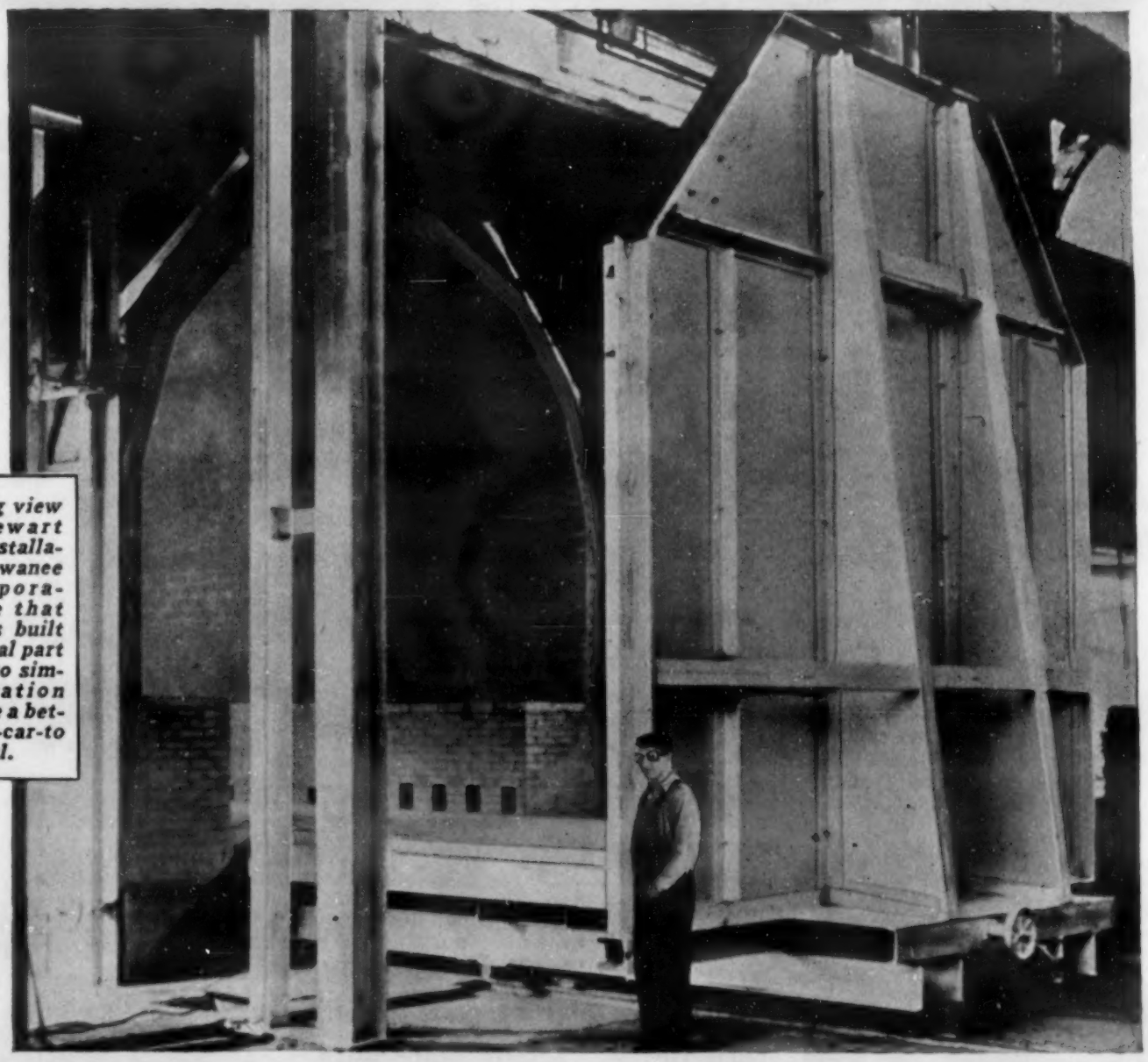

Operating view of the Stewart furnace installation for Kewanee Boiler Corporation. Note that the door is built as an integral part of the car to simplify operation and provide a better door-to-car-to furnace seal.

The big boilers and tanks turned out by the Kewanee Boiler Corporation require exact heat treatment for stress relieving. The Stewart car type hot air furnace illustrated above has the capacity for their largest pressure vessels and has been in operation since 1939.

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A letter, wire or 'phone call will promptly bring you information and details on STEWART Furnaces, either units for which plans are now ready or units especially designed to meet your need. Or, if you prefer, a STEWART engineer will be glad to call and discuss your heat-treating problems with you.

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The above unretouched photograph was obtained after the AGILE-made chisel was driven thru the ¼" armor plate with only five hammer blows. AGILE Silver-Green electrodes contain all the features of hardsurfacing, strength, toughness and hardness. Hardness 55-60 Rockwell C. Full information furnished on request.
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Machinability and Machining

Condensed from "Automobile Engineer"

As the machinability of a metal has a great effect on production costs, the main factors affecting machinability are discussed to obtain optimum production conditions. Machinability is not an absolute value but a quality usually expressed in comparative values in one of the following ways:

(a) The output obtained from a tool between refining, redressing or resharpening under constant and easily repeatable mechanical conditions.
(b) The speed with which cutting can be accomplished for a given tool life.
(c) The consumption power or energy expressed as torque, thrust, or even a rise in temperature.
(d) The type of finish resulting and the dimensional accuracy of the finished product.
(e) Comparison of stock weight removed per tool grind or in terms of time.
(f) As a cost item.

These values have time, speed, feed, depth of cut or tool life as variables, and conditions must be accurately stated.

Factors affecting the machining operations are (1) The classification of the material being machined, its regulation by analysis and the finding of a so-called machinability index; (2) the physical condition of the material indicating consistency of the product, whether heat-treated or not; (3) the tool, which should always be of the best, its nature, heat treatment, correctness of angles of clearance and rake, presentation of tool to its work and manner of securing in the machine tool.

Plain carbon steels or the lower alloy steels generally fail on the flank beneath the cutting edge. High speed steels fail by the cupping of the tool which is caused by the abrasive action of the chips causing local heating and thus softening the tool surface.

What Contributes to Machinability?

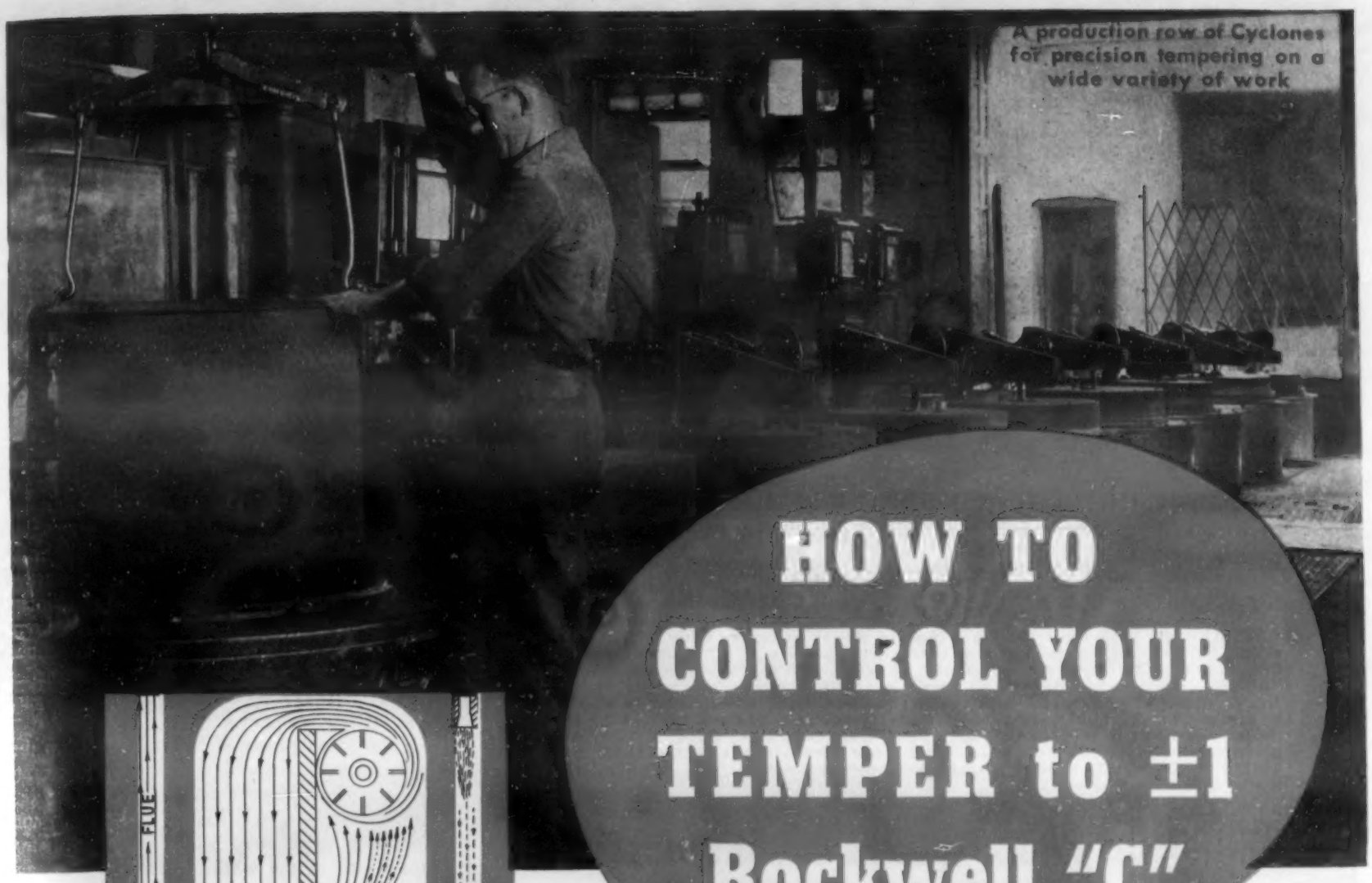
The main factors affecting *machinability* are: (1) Chemical composition, (2) the deliberate addition of elements known to promote free machining qualities, (3) properties directly traceable to the casting conditions, (4) heat treatment, (5) finish rolling temperatures, (6) physical properties — hardness, etc., (7) microscopical structure — grain size — type of annealing, (8) size of component being machined.

In gray cast irons, machinability is usually inversely proportional to the strength of the casting, although now alloy cast irons can be obtained with considerably greater tensile strength than plain cast irons without increasing machining difficulties.

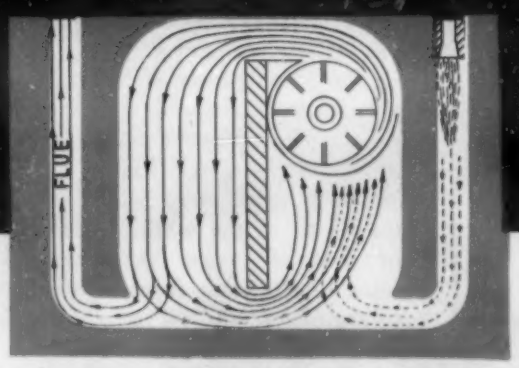
Of tool steels, the following is characteristic:

Structure	Hardness	Machinability
Laminated pearlite	228	poor
Mixed laminated pearlite and globular pearlite	196	fair
Globular carbides in ferrite ground mass	163	excellent

In carbon steels free machining is usually induced by deliberately keeping the sulphur content at a high level that under other circumstances would be considered excessive and deleterious to the steel. Small additions of lead also will facilitate free machining; additions of only 0.01 per cent



HOW TO CONTROL YOUR TEMPER to ±1 Rockwell "C"



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METSO CLEANERS

will show marked improvement in machinability, but the percentage can safely be raised to 0.25 without interference with other physical properties.

Non-ferrous Metals

Free machining qualities are now available in aluminum; if aluminum die castings have to be machined, a tipped tool is the best to use. Special free-cutting types of bronzes (copper-tin-silicon) are available in which the formation of chips is kept small. Magnesium alloys in general are of excellent machinability with smooth finish.

Monel metal is readily machinable, but slower speed and lighter cuts are required than on mild steel. To machine zinc, a keen, smooth tool edge is essential; high-speed steel tool bits with special tool angles are recommended. All brasses are machinable; best results are obtained with brass containing 55-63 per cent Cu; lead-bearing brasses also possess very fine machining properties. In case of medium red brass castings, machinability is improved without adverse affection of its physical properties if 0.5 per cent Ni is substituted for part of the zinc content.

The employment of cutting fluids has the advantage of acting as a coolant, a lubricant, easing the cutting operation, preventing distortion, causing small chips to be made and washing them away, and finally enhancing the finish of the work. Although a stream of cold air under pressure produces the same effect, some form of alkaline solution or emulsion of oil is usually employed. Machining operations should be carefully carried out, or defects may develop, such as ruptures, early fatigue, corrosion or erosion, cracks, etc.

—Donald Taylor. *Automobile Engineer*, Vol. 32, Feb. 1942, pp. 51-56.

Silver Plating Over Phosphate Coatings

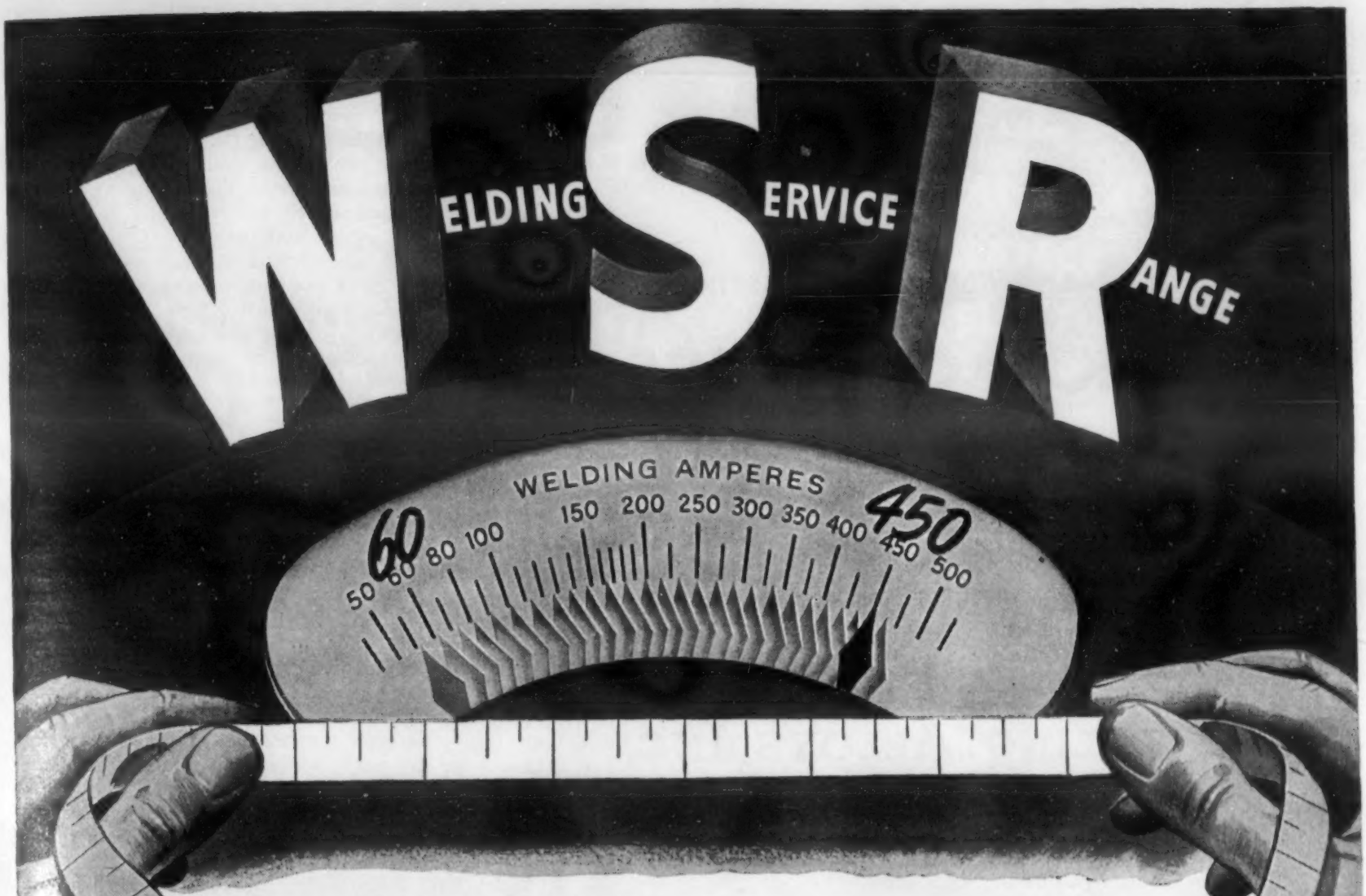
Condensed from "Metal Finishing"

A study was made to find a substitute for the commonly used nickel or copper strikes used on steel in preparation for silver plating. It was found that a 30 second dip in 10 to 25 per cent phosphoric acid solution at room temperature, followed by a single strike in a silver cyanide strike bath, after which silver was deposited from a standard silver cyanide bath, produced a remarkably adherent deposit.

Salt spray tests indicate that the corrosion resistance of test panels plated by the above procedure is about the same as the corrosion resistance of panels plated in the usual manner with two silver strikes.

The deposits produced by the phosphate dip procedure was sufficiently adherent to withstand the deformation produced by the Erichsen cup test without peeling. Annealing (in air?) did not appear to affect the adhesion, but annealing in a nitrogen atmosphere at 750 deg. F. for 1 hr. resulted in poor adhesion. Photomicrographs of the deposits are given.

—P. J. Lo Presti, *Metal Finishing*, Vol. 40, Oct. 1942, pages 533-536.



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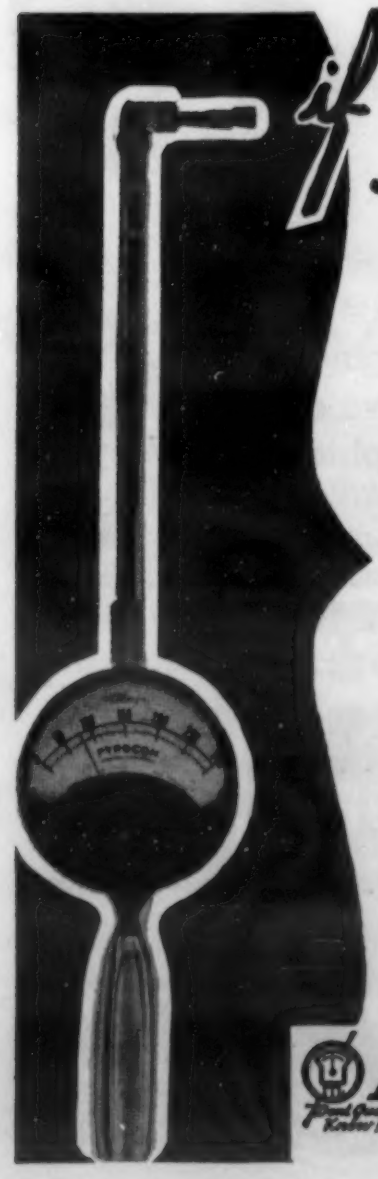

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WHEN you need it!

Today, with a shortage of industrial instruments looming as war production's biggest current problem, ***portability*** assumes a new significance . . . That is **one** reason it will pay you to investigate the features of the ALNOR PYROCON Pyrometer, ***now!***

THE ALNOR PYROCON is a sensitive, accurate and completely portable surface type pyrometer designed for reaching difficult spots. It is supplied with ten different and instantly interchangeable thermocouples to assure the scientifically **right** tip for any flat, curved, stationary or revolving surface . . . a fact which proves its versatility is **engineered,** not make-shift!

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For further details and prices write for Bulletin No. 3511-A

Illinois Testing Laboratories Inc.

425 N. LaSalle St., Chicago, Illinois

Chrome-Plating of Tools

Condensed from "The Iron Age"

A new process developed by the Crowell-Collier Pub. Co. consists in grinding and honing the cutting edge of a tool with a fine stone. The cutting edge is then dipped in 10 per cent HCl for 30 sec. and rinsed with water.

A plating bath is made up of 50 oz. of 99.75 per cent chromic acid, dissolved in water to which 0.5 oz. of concentrated H_2SO_4 is added. The solution is then made up to 1 gal. The temperature of the bath is held between 110 and 150 deg. F. and current densities range from 130 to 200 amp. per sq. ft.

Plating Technique

The tool is used as the cathode and is placed in the solution to a depth of ¼ in. above the cutting edge. The anode is preferably lead, although stainless steel can be used. In the first step, the current is reversed for a short time from 200 to 400 amp. per sq. ft., making the tool the anode.

At the end of this period the current is again reversed so that the tool once more becomes the cathode, at 130 to 200 amp. per sq. ft. When this is done, the current is decreased immediately to 120 to 180 amp. per sq. ft., and plating proceeds for a period of 1 to 4 min. for each sq. in. of steel surface exposed.

After plating, the tool is rinsed in cold water and dried. The plating should be semi-lustrous blue-white. After this, the tool is placed in a heated oil bath (350 deg. F.) for 1 hr. This oil bath releases hydrogen in the deposit and eliminates embrittlement.

To avoid bead formation of the cutting edge that is plated more heavily than the standard of less than 0.0001 in., it is necessary to raise the temperature of the plating bath to 150 deg. F. to slow down the rate of deposit.

The process has been released by the company for the war's duration for use on Government work, without royalties or other charges. This process is known as the Lundbye process and gives highly satisfactory results with drills, taps, reamers, files, end and face mills, broaches, punches, dies, gear cutters, etc.

Tool Life Increased

Tests conducted showed increased tool life for molybdenum high speed steel external center and high speed steel cutters used on Fellows gear shapers. In the test two gear cutters were used, one being plated to a depth of 0.0001 in. and the other was unplated. Cutters were identical. Machine speed for chromium plated cutter was set at 184 strokes per min. with 1080 strokes per revolution. The gear made two revolutions to remove 0.040 to 0.045 in. of stock over pins. This cutter finished 15 gears of 48 teeth each, with tooth width of 1¼ in. Unplated cutters complicated the same test.

Then the plated cutter was remounted and finished 15 gears with 52 teeth, a grand total of 1500 teeth. The cutter was found in good condition. The unplated cutter showed great errors in cutting the twentieth gear.

Down with Down Time ... Up with Production!

A few years ago, ordinary cold drawn copper ... because of its high electrical and thermal conductivity ... was often used for resistance welding electrodes. But pure copper softens and "mushrooms" at the relatively low temperature of 390°F., resulting in poor welds and much down time for dressing.

Today, thanks to Mallory research, there are many improved electrode materials available. These special non-ferrous alloys and Elkonite* inserts produce more welds between dressings and need replacement less often. They speed resistance welding of similar and dissimilar metals ... from A to Z ... from aluminum to zinc!

Mallory 3 Metal*, for instance, is widely used for spot welding tips, seam welding rolls and flash welding dies. More than a dozen ferrous and non-ferrous metals and alloys can be joined faster, more soundly, and at lower cost, by using electrodes made of Mallory 3 Metal. These include cold-rolled steel, pickled hot-rolled steel, stainless steel, phosphor bronzes, silicon bronzes, nickel alloys, nickel silver and zinc.

Elkonite* (used as an electrode facing or insert) is recommended for projection and cross-wire welding, electroforging, electrical upsetting and electric brazing of all metals; for spot welding of pure copper, copper alloys and certain dissimilar metals; for flash and butt welding where the current density is extremely high.

Elkaloy A* is the accepted electrode material for spot, seam and flash welding aluminum and its alloys, scaly metals and most types of plated metals.

Best results in welding materials of high electrical resistance such as Nichrome, Monel Metal and stainless steel are obtained, in many cases, by tips or wheels of Mallory 100 Metal.

INFORMATION FREE! Mallory engineers can help you choose the right electrode material, the correct design and cooling, for each specific resistance welding job. Write us for detailed information. Ask for your free copy of the MALLORY RESISTANCE WELDING DATA BOOK, if you don't have one. This book is a practical manual, widely used by welding engineers in the aircraft, shipbuilding, electrical manufacturing and dozens of other essential industries! Write us today.

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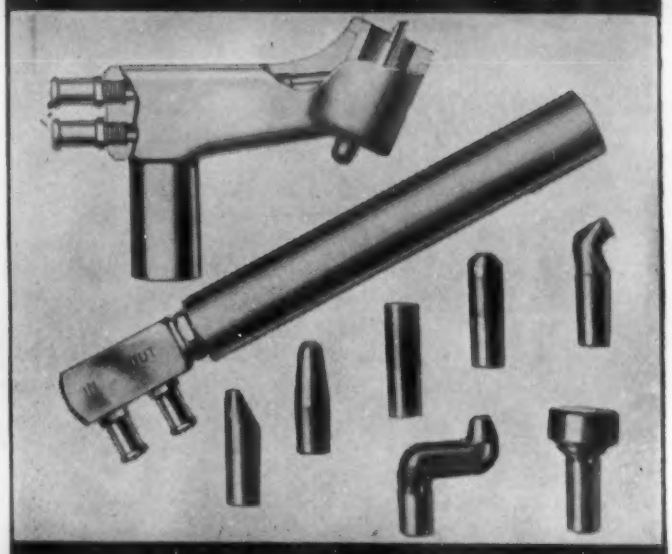
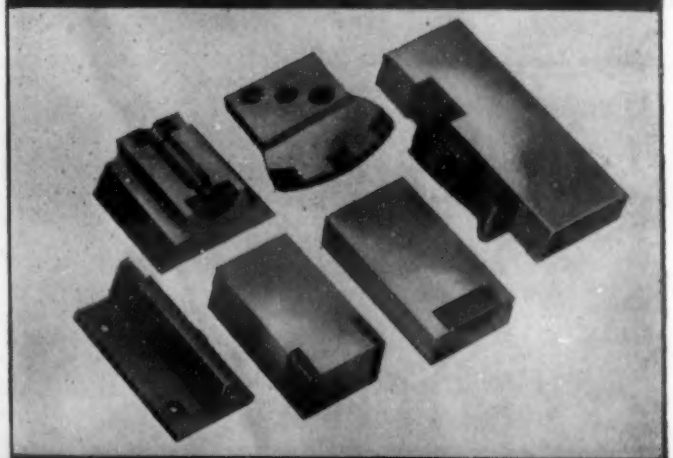
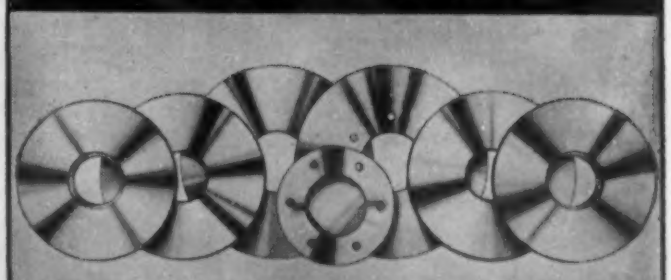


SPOT WELDING TIPS AND HOLDERS



FLASH, BUTT, PROJECTION WELDING DIES



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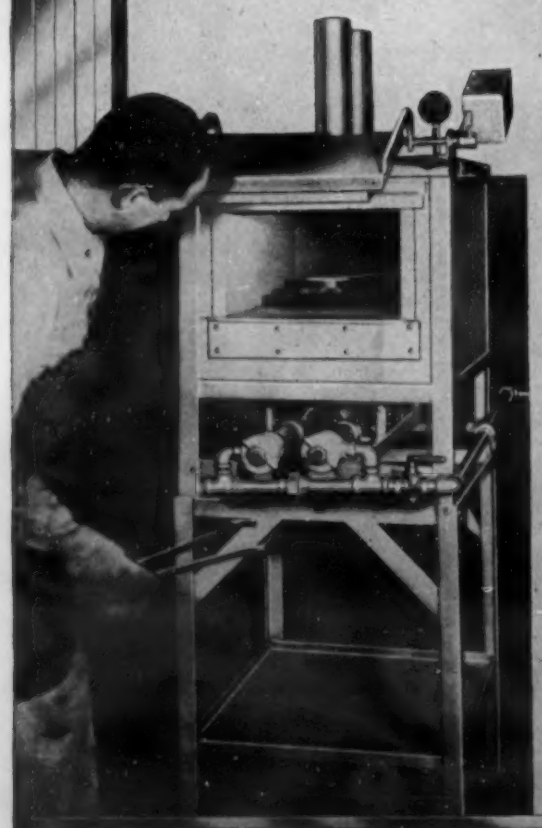

BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6" x 8" x 5½", to No. 24, which is 12" x 20" x 8" as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6" x 12" x 5", is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½" x 15" x 2½" high.

Special size furnaces built to your order. Write for descriptive folder and prices.

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113 Astor St., Newark, N. J.

Tabulating results of the test, the plated cutter had cut the equivalent of 5056 teeth with a tooth width of 1¼ in., while the unplated cutter had cut only 1760 teeth of the same tooth width. A cast steel armor plate manufacturer had similar success with the chromium plated tools.

Tests were also run on 155 and 20 mm. shells and results showed the advantages of plated tools. Tests made by various manufacturers, along with those made by the Pittsburgh Testing Laboratory, indicate the chromium plating process for high speed steel tools increases tool life. The chromium plate increases the hardness of the tool bearing surfaces, the inherent "oiliness" of chrome prevents galling and building up of cuttings or drillings, and the low coefficient of friction of chromium reduces heating of the tool while in operation.

—Thomas E. Lloyd, *Iron Age*, Vol. 150, Dec. 10, 1942, pp. 43-49.

Baking Ordnance Finishes

Condensed from "Proceedings," American Electroplaters' Society

In a discussion of military applications of organic finishes, the author describes the type of finishing material used in the various applications and compares drying schedules for baking with convection heating and with infra-red radiation heating. The time factor is favorable to the infra-red method of baking.

The design of infra-red heating equipment is discussed. The rate of temperature rise of the work in an infra-red oven is dependent on the ability of the surface to absorb the radiant energy and on the concentration of the energy received. The final, or equilibrium temperature is reached when the rate of heat loss to the surrounding atmosphere is equal to the rate of energy input.

Heat losses to the air depend on the difference between the temperature of the air and of the heated surface. Elevated air temperatures in radiant ovens reduce such losses and thus make possible the maintenance of the required work temperature with minimum energy input.

Elevated air temperatures also partially cure the finish on subordinate surfaces not otherwise exposed. At the same time greater latitude is permitted between variations in mass, color, size and shape of the product.

In the present day radiant heat oven, the elevated air temperature is obtained as a by-product simply by fully enclosing the entire system. Such a system is called a radiant-convection system.

A typical oven of this type for baking a normal synthetic enamel would have four zones. The entering zone is a pre-heating section heated by hot air drawn from the radiant system. In this zone the work is pre-heated and high boiling volatile solvents are removed. The work then enters a zone of high energy concentration in which it is heated rapidly to baking temperature.

The third zone is one of lower energy concentration in which the temperature reached in the second zone is maintained for any prescribed period of time. The work then enters the fourth zone, which

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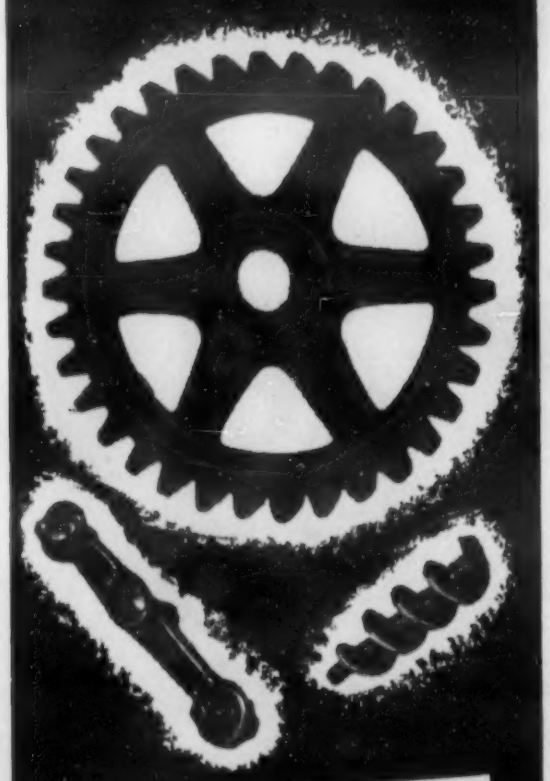

STAINLESS STEEL CASTINGS

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ATLAS

STAINLESS STEEL CASTINGS

Division Atlas Foundry Co.

520 LYONS AVENUE IRVINGTON, N. J.

may be called the heat retention section, in which there are no lamps.

The heating cycle is completed in this section by the utilization of convected heat and by the residual heat in the product itself. Actual oven design should take account of: (1) dimensions of the product; (2) thermal characteristics of the material; (3) temperature requirements of the process; (4) time cycle requirements; (5) method of handling the product; (6) safety considerations; (7) space limitations; (8) existing investment to be utilized.

Among the advantages of radiant-convection heating equipment are: (1) low initial and operating costs; (2) no warm-up period; (3) greater coordination with other processes; (4) flexibility; (5) savings in floor space; (6) consistency of results; (7) ability to observe the operation of the oven at all times.

Radiant heating has been applied with advantage to other processes, such as moisture drying, heating of thermo-plastic sheet materials prior to forming, melting of paraffin compounds on plated objects, and shrink fitting of gears and bearings.

—Thomas P. Cusack, Jr., *Proc. Am. Electroplaters' Society,* 1942, pp. 52-58.

Annealing of Cold-Worked Steel

Condensed from
'Mitt. Kaiser-Wilhelm-Inst. Eisenforschung"

Systematic investigations were made to determine the critical heat treatment, in particular the influence of the cooling condition on the deterioration of the mechanical properties of mild steel.

For this purpose, rods of 18 mm. diameter with 0.08 C, 0.05 Si, 0.06 Mn, 0.005 P, and 0.01 per cent S, which had been cold-rolled with 5, 7.5, 10, 12.5, 15 and 20 per cent reduction, were cut in 10 mm. long cylindrical pieces and annealed at 620, 650, 680, 710, 750, 800, 830, 860 and 900 deg. C. (1150 to 1650 deg. F.) for 10, 30 mins., 1, 2, 4 and 8 hrs. Half of the specimens were cooled in the furnace, the other half in air. The hardness and structure were examined.

A clear distinction between a deterioration by crystalline recovery and by recrystallization could be made for temperatures up to 710 deg. C. (1310 deg. F.), especially for air cooling. At higher temperatures, new grain formation and deterioration were completed in general already after the shortest time of annealing; this took place, however, also at lower temperatures for greater reduction.

At 710 and 750 deg. C. (1310 and 1380 deg. F.), the specimen reduced with 7.5 and 20 per cent showed an extraordinary coarsening of the grain which, however, decreased considerably with increasing cold-deformation. In the same temperature range, strongest at 750 deg. C. (1380 deg. F.), the hardness decreased below the original value whereby the samples reduced between 10 and 20 per cent showed approximately the same values in spite of the considerable differences in grain size. The specimens cooled in air had about 5-15 Brinell units higher hardness than those cooled in the furnace.

The duration of annealing did not have an appreciable influence on hardness except in the immediate proximity of the be-

For better control in heat treating metals

Essential in controlling quality of treated metals is maintenance of uniform composition. Ranarex* makes this easy. Just note the specific gravity of the raw gas and atmosphere gas, as indicated by this instrument. Ranarex is accurate, tough, easy to operate, adaptable to stationary or portable use.

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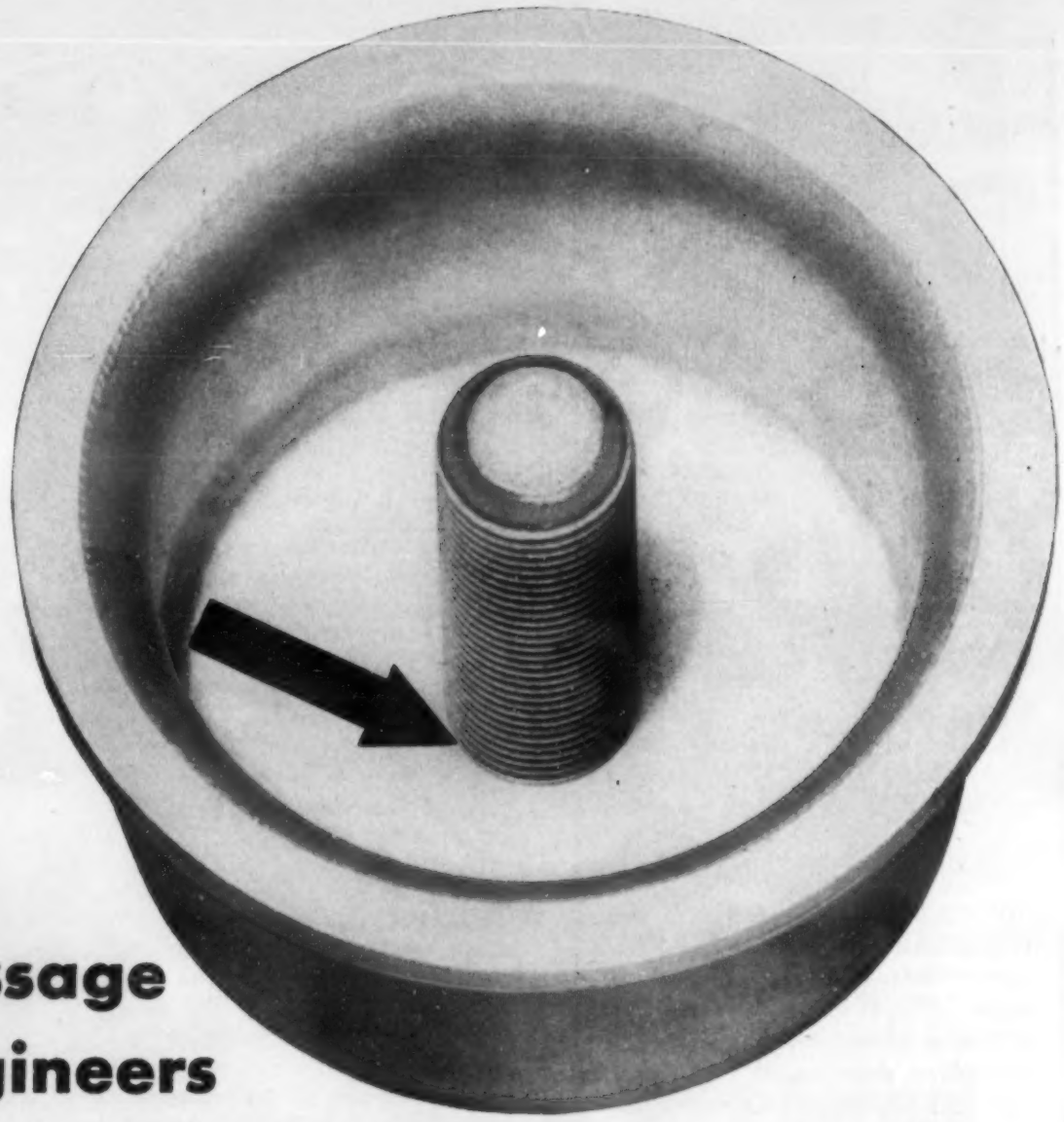
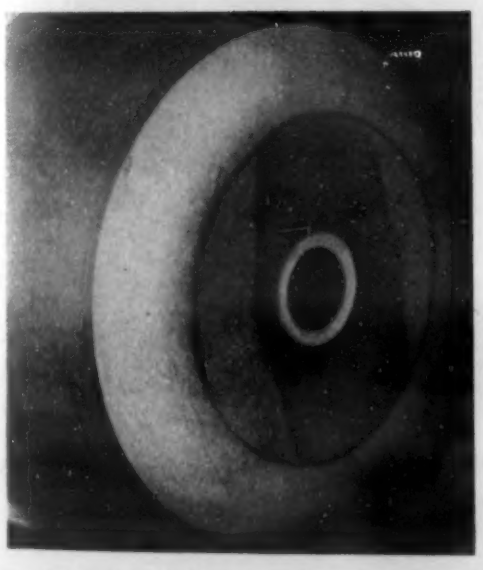


This little part holds an important message for Design Engineers



Note in this back view the complete penetration of the alloy to all parts of the joint —a feature of Sil-Fos and Easy-Flo action. Their extreme fluidity is the reason—and is of basic importance because thin films make the strongest joints.

It is part of the balancing mechanism on controllable pitch aircraft propellers. The important advantage it offers is in its **silver alloy brazed construction**—a construction that is growing fast because it conserves metals, man-hours, machines and costs.

Formerly machined from solid metal, it is now made of a steel stamping to which the stud is brazed with the low-temperature silver alloy Easy-Flo. This new design is made in far less time, uses much less metal, frees machines for other work, is lighter in weight, yet in strength and reliability is fully equal to its predecessor. Naturally the cost is lower.

SIL-FOS and EASY-FLO make BRAZED CONSTRUCTION PRACTICAL

These two low-temperature silver alloys are the key to the success of brazed construction because they make joints as strong as solid metal—and due to their combination of low working temperatures and silver content, they make these joints with exceptional speed, reliability and low cost.

Write for Bulletin No. 12—This bulletin gives full details about Sil-Fos and Easy-Flo and contains valuable information on joint designs, heating methods and fast production procedures. Your copy will be mailed promptly on request. Write today.

ARMY (E) NAVY
1ST AWARD August 1942
2ND AWARD February 1943

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ginning of recrystallization. The ferrite formation was uniform in the specimens reduced with 5 per cent at all annealing temperatures and does not differ from the cold-rolled state. The reduction of 5 per cent lies therefore below the threshold of deformation required for recrystallization in this material. A diagram represents the times after which recrystallization and structure are completed for the different reductions.

—A. Pomp & G. Niebsch, *Mitt.-Kaiser-Wilhelm-Inst. Eisenforschung Düsseldorf*, Vol. 24, No. 5, 1942, pp. 47-59.

Heat Treating Small Arms Parts

Condensed from
"Canadian Metals & Met. Industries"

The day when heat-treating procedures were set up more or less empirically in the heat-treating department is past. At the plant of the John Inglis Co. the metallurgical laboratories put down the exact requirements from the point of temperature and time methods of heating and cooling, and properties to be attained. It sets up inspection standards and specifies the hardness to be obtained.

In connection with the carburizing operations in the Boys guns heat-treating department, considerable use is made of copper plating to permit the selective carburization required for quite a number of parts. For carburizing the breech block, certain parts which are not to be carburized are given a coat of protective paint and the copper is then stripped off from the balance. After carburizing and cleaning, the breech block is coated with copper again and heated to drive the carbon farther into the block without carbon addition.

Specially built furnaces, with doors on each end, capable of handling all types of gun barrels are electric ones designed for hardening and tempering. In the hardening operations, the barrels, fed on a rack, are allowed to roll slowly through the furnace and the doors are not closed all the way. No protective atmosphere is employed. Tempering operations are of a batch nature due to the necessity for holding the steel at temperature to soak.

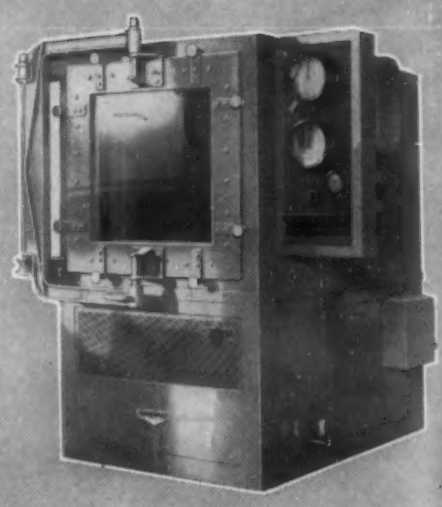
Localized Hardening by Induction

Induction heating is employed for localized hardening also in the brazing of certain parts and the shrinking on of other components. Standard power units with the heating coils or fixtures designed for the particular job are used. An automatic timer indicates the end of the heat treatment cycle. The induction hardening process lends itself to the use of continuous feeding devices. In one instance a conveyor belt carries pins with the heads passing through an elongated coil at a speed which just brings them to hardening temperature and the pins fall from the conveyor into the oil quench.

Parts come from the induction hardening process cleaner and subjected to a much more accurate temperature control than is possible where the temperature is judged by the human element.

Oxy-acetylene torch tempering is employed along the edge to prevent holes from breaking out. Certain parts on which it is required to have each end hard and the

KOLD-HOLD



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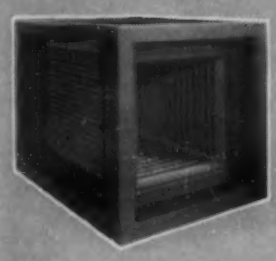
Ball-bearing suspension and guide-arm make doors easy to operate and keep in perfect alignment.



Cold-Liner interior of KOLD-HOLD Stratosphere, showing rugged, heavy-duty construction.

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A Problem in Electroplating and How It Was Solved

The Problem

An Eastern plating company had a contract for anodizing aluminum parts. The contract would be completed in about 9 months. The job would require a power supply of 500 amperes, 40 volts.

When, if ever, there would be another job requiring 40-volt equipment was uncertain. Most likely the next job would be low-voltage plating requiring 6 volts. The problem was: What equipment would serve both these widely different requirements.

The Solution

Here's how the needed flexibility was obtained: Seven standard 500 ampere, 6-volt G-E Copper Oxide Rectifiers were purchased. By a series connection and regulator control, this equipment was adapted to operate over a range from 1 to 40 volts at 500 amperes. When the contract was completed, the same equipment was relocated at two different points in such a way that 4 units were used for a plating job requiring 12 volts, 1000 amperes, while the other 3 units were set up on a job requiring 6 volts, 1500 amperes.

This illustrates only one of the many electroplating power supply problems that can be solved through flexible G-E Copper Oxide Rectifiers. Whatever your problem, General Electric Metallic Rectifier Engineers will be glad to consult with you. For additional information, write to Section A 434-111 Appliance and Merchandise Dept., General Electric Co., Bridgeport, Conn.

GENERAL ELECTRIC

Conservation is "Personified" in Amsco Alloy *Flexboxes* . . . . .

From the time a heat treating box is first put in service, destructive forces are fighting to shorten its life: high furnace temperatures, variable temperatures during the heat treating cycle, differential heating, and corrosive vapors. All such containers are bound to burn out, crack or break, sooner or later. But the "Flexbox" design and the high heat resistance of Amsco Alloy combine to counter-attack with an effectiveness which usually makes this "later."

Patented "Flexbox" heat-treating and carburizing boxes are made of the grade of Amsco Alloy best adapted to the specific application.

The "Flexbox" body is made in three or four separate cast pieces. The sides have tongue and groove joints and are held in place by a tack weld. The sides and ends are corrugated (when practicable) to give greater strength at high temperatures, and the bottoms have legs for use in batch type furnaces, providing complete circulation around the container. The covers are light cast pieces, furnished either flat or corrugated. As in the case of all Amsco Alloy parts, X-rays of castings selected for checking minimize the possibility of placing defective parts in service.

Sufficient clearance is allowed in the joints to absorb expansion from heating of the parts, and for contraction in cooling without appreciable loss of gas. This feature is highly effective in retarding distortion or cracking of the castings. Should an occasion arise wherein it is advisable to replace a section of a "Flexbox," it can be done without difficulty.

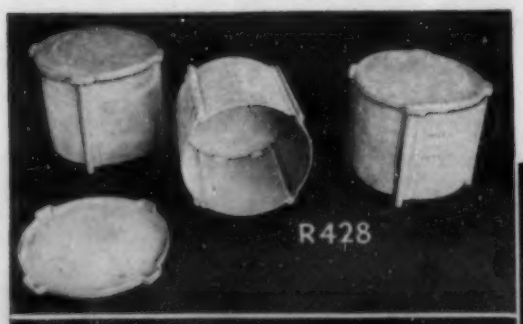
Using "Flexboxes" is one sure way to reduce heat treating box replacement costs, and to conserve metal.

Write for bulletin on Amsco Alloy "Flexboxes."

R-428 Cylindrical "Flexboxes" made in four sections.

R-666 "Flexboxes" for carburizing at 1650-1750° F. with side lugs for handling loaded boxes. Legs are welded on instead of being cast integral to avoid casting stresses.

R-610 "Flexboxes" made in three tongue and grooved sections, cover and flanged bottom which clamps to sides.



Better steel requires more scrap!

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center tougher are hardened all over and then flame tempered as required. Tempering furnaces are operated at temperatures low enough so that no protective atmosphere is required. Bennett "Interoval" gas furnaces with vertical structure are useful for long reamers and other parts that would tend to sag, if charged in horizontally. Lindberg furnaces are used for treating long pieces and for cyanide treatment of parts and fixtures, requiring a light case. Nitriding pots and lead pots are used to a limited extent.

Use of Austempering

Austempering is applied where a tougher structure is required. On a Browning breech block the treatment includes heating to 1525 deg. F. in the lead bath and quenching at 650 deg. F. in a lead-antimony mixture with the tempering salt on top.

Hayes controlled atmosphere electric furnaces are used in nearly all cases where the part is made from a direct hardening steel and must be hardened over all. These furnaces are used for the high temperature treatment of high speed, etc. with a lead pot, at temperature of 900 deg. F., used for quenching many high-speed steel parts from the high temperature furnaces.

—*Can. Metals & Met. Inds.*, Vol. 6, Jan. 1943, pages 2-5.

Grinding Tool Steels

Condensed from "The Iron Age"

When visible, cracks are easily recognizable. That is, the direction of the principal cracks is always perpendicular to the direction of grinding. Also they are connected by smaller secondary cracks.

Suspected but invisible cracks produced by improper grinding should be located by magnetic methods. By this method the tool steel is placed on a link magnet with the flux longitudinal so that it will intercept any cracks at right angles. The steel is sprayed with kerosene which has in suspension finely divided particles of magnetic iron oxide.

Hardening and quenching cracks are distinguished from grinding cracks in that they are usually larger and fewer in number. Also they are symmetrically disposed, following holes, corners, etc.

Together with causing cracks, improper grinding may also damage tools in other ways, such as softening. Annealed high-carbon steels may be ground so drastically that they harden.

As a guide, tool steels may be divided as follows: (1) Hard steels: All steels containing over 0.55 per cent C, or which are capable of being hardened to less than 61 Rockwell C; (2) Tough steels: Those containing less than 0.55 per cent C and tempered so that the hardness does not exceed 61 Rockwell C. Since tool steels are weak and brittle, it is advisable not to be misguided by strength and toughness of test figures.

Likewise, the surface finish on a bridge member has little effect on the strength, whereas the direction and kind of grinding applied to a delicate cutting edge has much to do with its strength. Defective impact tools also are dangerous.

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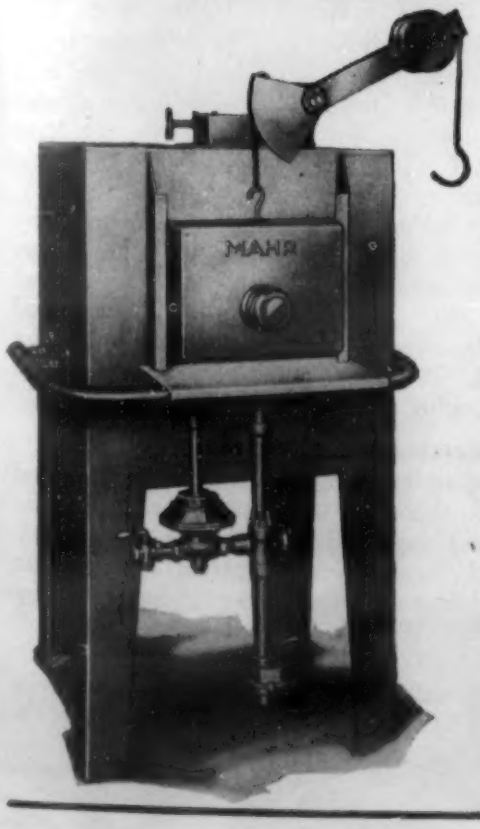

Atmosphere, temperature and hardening are perfectly controlled in this MAHR Tool Furnace. It is especially adapted for using carbonaceous muffle blocks, so that stock being treated will come out bright, scale-free—and will not be decarburized. You are sure of accurate, pre-determind results.

Also furnished without muffle as a direct fired furnace, where effect of combustion gases is not detrimental to stock, or where refinements of a protective atmosphere are not necessary.

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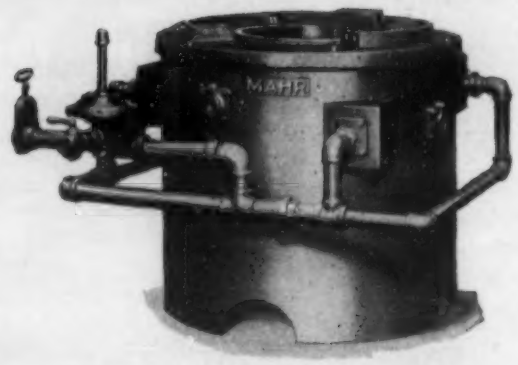

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Baking	Pusher	Burners
Hardening	Roller Hearth	Blowers
Forging	Continuous	Valves
Drawing	Pot	Smithing Forges
Stress Relief	Rotary	

Tough tool steels when exposed to a steady bending load may be more dangerous than the hard variety. This is because of its natural "springiness" or resilience. When the specimen breaks, the halves of the tough steel will fly with terrific force, while the halves of the harder and more brittle steel are not so likely to fly.

The following conclusions as to the dangers associated with tool steels have been arrived at: (1) In impact, the hard steels are dangerous; particles spalled at the corners and edges are most likely to cause injury; (2) tough tool steel is probably the safest for use in impact; (3) hard steels are those containing over 0.55 per cent C, or over 61 Rockwell C hardness; and (4) all surfaces subject to impact should be ground to remove scale and projections.

—J. E. Ebb, *Iron Age*, Vol. 151, Jan. 14, 1943, pp. 28-32.

Brazing High-Speed Steel Tips

Condensed from "The Iron Age"

High speed steel is being conserved because it contains a large percentage of strategic tungsten, molybdenum, chromium, vanadium and cobalt. In order to minimize waste due to the fact that only a small amount of a tool is used up in cutting, high speed steel tips are joined to low alloy steel shanks.

Braze-Hardening

This is accomplished by a method called braze-hardening. This may be carried out in a furnace designed for copper brazing of carbide tips. The procedure found satisfactory for tipping tools with molybdenum high speed steel is accomplished by cleaning the tip shank in carbon tetrachloride. Then the shank end is covered with powdered copper brazing flux and the tool is pushed partly into the muffle furnace.

After the flux is melted, the shank and tip are fitted together with copper strips in between and on top of the tip and flux is applied. The tip is preheated to about 1500 deg. F. and it is moved into the high heat portion of 2225 deg. F.

The tool is withdrawn from the muffle and the tip is pressed in place. When the copper sets, the tip end is quenched in oil to below 200 deg. F. After this the tipped tool is tempered at 1050 deg. F. for 2 hrs.

Silver brazing can also be used, but the low melting point of silver solder (1200 deg. F.) prohibits brazing. However, by using previously hardened tips, it is possible to braze the tip and temper it simultaneously. High - carbon, high - vanadium high speed steel and cobalt high speed steel are particularly suited to this method since they have greater resistance to softening.

Braze-Tempering

In this method, known as braze-tempering, the joining surfaces of the shank and tip are cleaned and covered with a silver brazing flux made in paste form. The tip is fitted on the shank with a strip of silver solder 0.003 in. thick. This is heated with an oxyacetylene torch on the bottom until the heat soaks through the shank and melts the silver solder. Overtempering of the tip should be avoided by minimizing the time between melting and solidification of the solder. The tip is pressed in place.

The tipped end is quenched in oil to drop the temperature to 1000 deg. F. The tool is allowed to cool in air so that transformation of the retained austenite may occur more uniformly and with less danger of cracking the tip. Tempering at 1050 deg. F. for 1 hr. is recommended for stress relief.

In taking rough cuts, sufficient heat may develop and cause softening of the silver alloy braze and consequent movement of the tip. For this reason braze-tempered tools should be used only for finishing cuts. Braze-hardened tools may be used for either rough or finishing cuts.

Advantages of Tipped Tools

In addition to conservation of high speed steel, there are other advantages for using tipped tools. Since only the tip is hardened, there is less danger of tool cracking or harmful internal stresses being set up than in the case of hardening a solid tool. Breakage may be avoided by using tough alloy steel shanks. Cutting efficiency will also be increased since it is easier to obtain full hardness in a tip.

—B. S. Lement & W. B. Kennedy, *Iron Age*, Vol. 150, Nov. 19, 1942, pp. 55-58.

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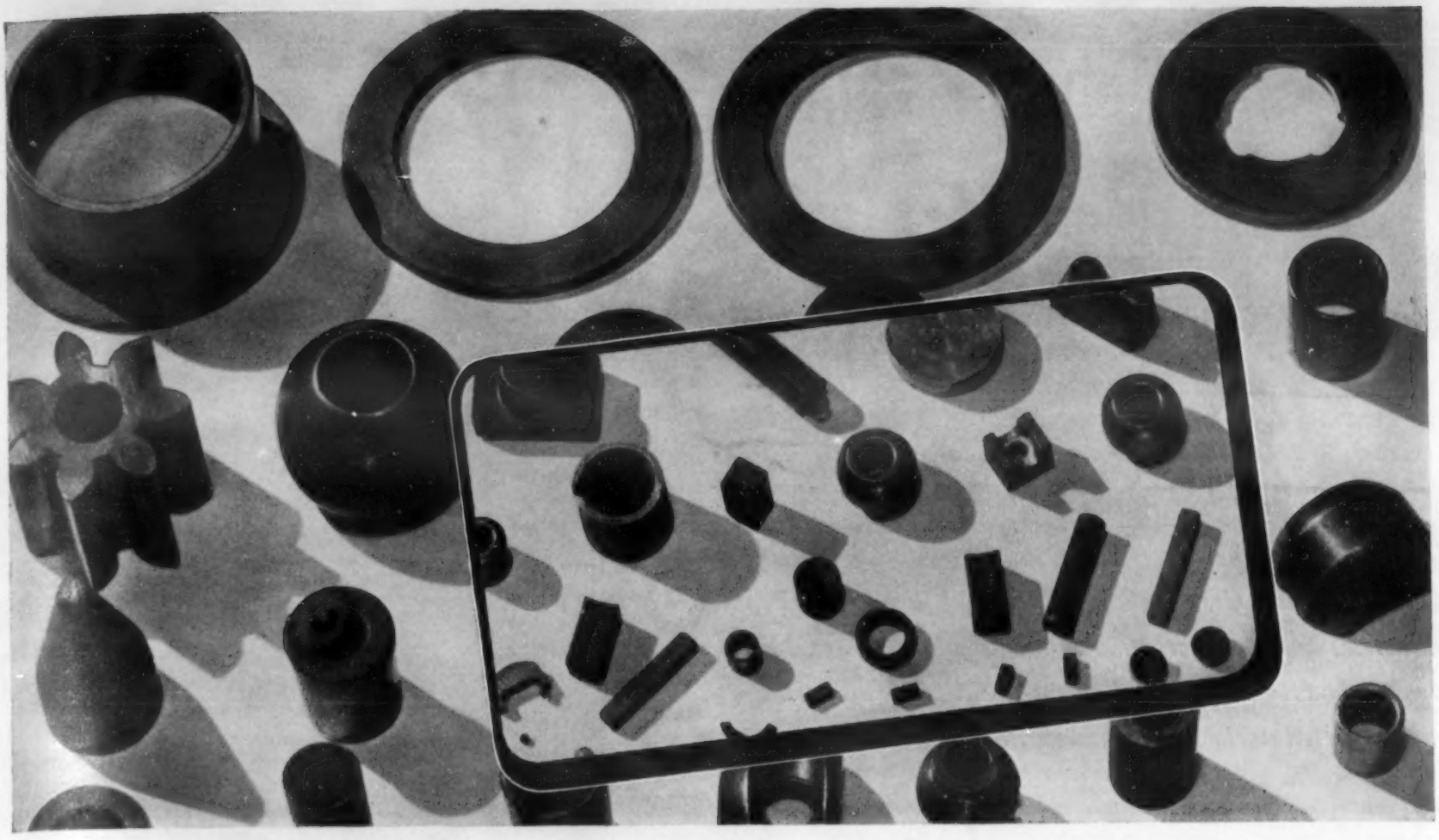

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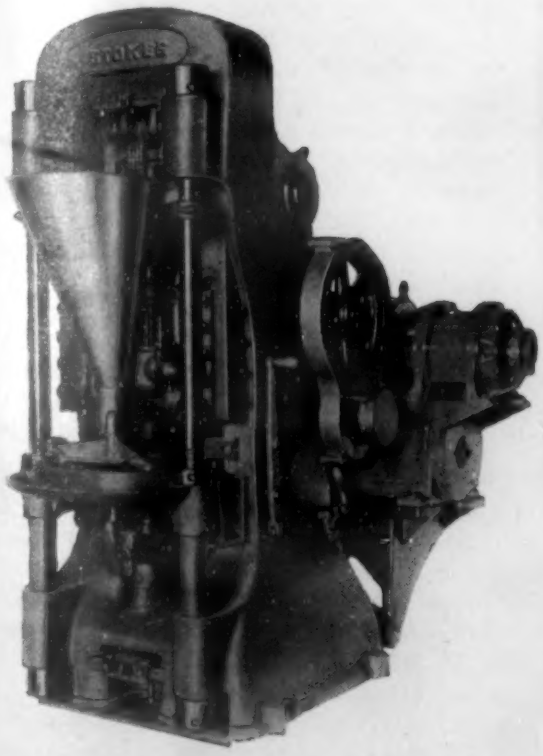

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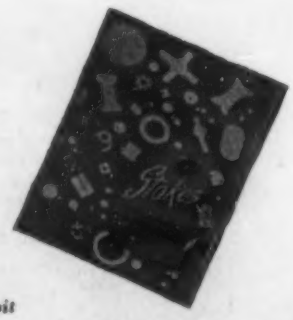

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4 Materials and Engineering Design

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

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Resilience of Duralumin vs. Steel

Condensed from "Light Metals"

If a metal is strained axially within the elastic limit with a tensile stress f, length L, and modulus E, the extension is $l = fL/E$ and for the resilience work (work required to deform the metal elastically), one can write $\rho = fL/2Efa$ since the area under the stress-strain curve in the elastic region (elastic work) is $\frac{1}{2}fa$ (l) where a is the area. Thus $\rho = f^2/2E$ for a unit volume. This last expression gives the maximum amount of energy which can be absorbed by a piece of material without causing permanent deformation, where f is the yield strength or proof stress.

If steel and duralumin of the following mechanical properties are compared, steel: yield strength = 18 tons per sq. in., $E = 30\times10^6$, specific gravity = 7.84, and duralumin: yield strength = 15 tons per sq. in. (0.15% proof stress), $E = 10\times10^6$, specific gravity = 2.79, we obtain ρ duralumin/ρ steel = 2.08.

Hence a given volume of duralumin of the above properties is capable of withstanding without plastic deformation about twice as much energy as an equal volume of steel of the above properties. However, in engineering practice, the duralumin would be greater in section than steel by the ratio of the yield strengths. Multiplying 2.08, then, by 18/15 we obtain 2.5. The ratio of the weight of the steel to duralumin on this basis would be 1:0.43.

Loading Conditions

Sudden loading: If a tensile stress is applied suddenly to a bar of metal, the instantaneous strain produced is twice what would be produced under gradual loading, or strain (e) = 2P/aE, but the corresponding stress (f) = 2P/a, hence the resilience per unit volume is still (ρ) = $f^2/2E$ (where f has twice the previous value).

Impact loading: If a weight P is allowed to fall a distance h, it exerts an axial stress on a bar of metal of length L. The total elongation is δL, and using the previous notation, one can write $P(h + \delta L) = (Ee/2)a\delta L = P'\delta L/2$. Further analysis shows that f impact = 2P/a or $\rho = f^2$ impact/2E, the same expression found before for the case of gradual or sudden loading, except that a different f is used.

Torsional Resilience: Just as axial loading results in a resilience $\rho = f^2/2E$, so shear resilience is given by $P^2/2N$, where P is the intensity of the uniform shearing stress and N is the modulus of rigidity (shear modulus). If a solid shaft of radius R and length L is subjected to a torsional strain so that the maximum fibre stress is under the elastic limit, f_s (max. fibre stress) = rf/R where r is the radius of any elemental tube. The shear resilience of the tube will be equal to $P^2 (2\pi Lrdr)/2N$ and for the whole shaft $PN = \pi R^2 L f_s{}^2/4N = f_s{}^2/4N$ for unit volume.

Comparing steel of the following properties: f_s = 14 tons per sq. in. and $N = 12\times10^6$, with duralumin of the following properties: f_s = 9.8 tons per sq. in. and $N = 3.8\times10^6$, the ratio of the torsional resilience is 1.55 for equal volumes. Here, again, a more logical comparison would be on the section sizes used in torsion rather than on the basis of equal sections (or volumes). The diameter necessary for a given horsepower is proportional to the third root of $1/f_s$, hence the ratio of steel diameter to dural diameter on this basis is 1 to 1.13. Multiplying 1.55 by $(1.13)^3$ gives 1.98, or duralumin in torsion has 1.98 the resilience of steel for shafts of equal horsepower. The weight ratio of steel to duralumin is 1:0.45.

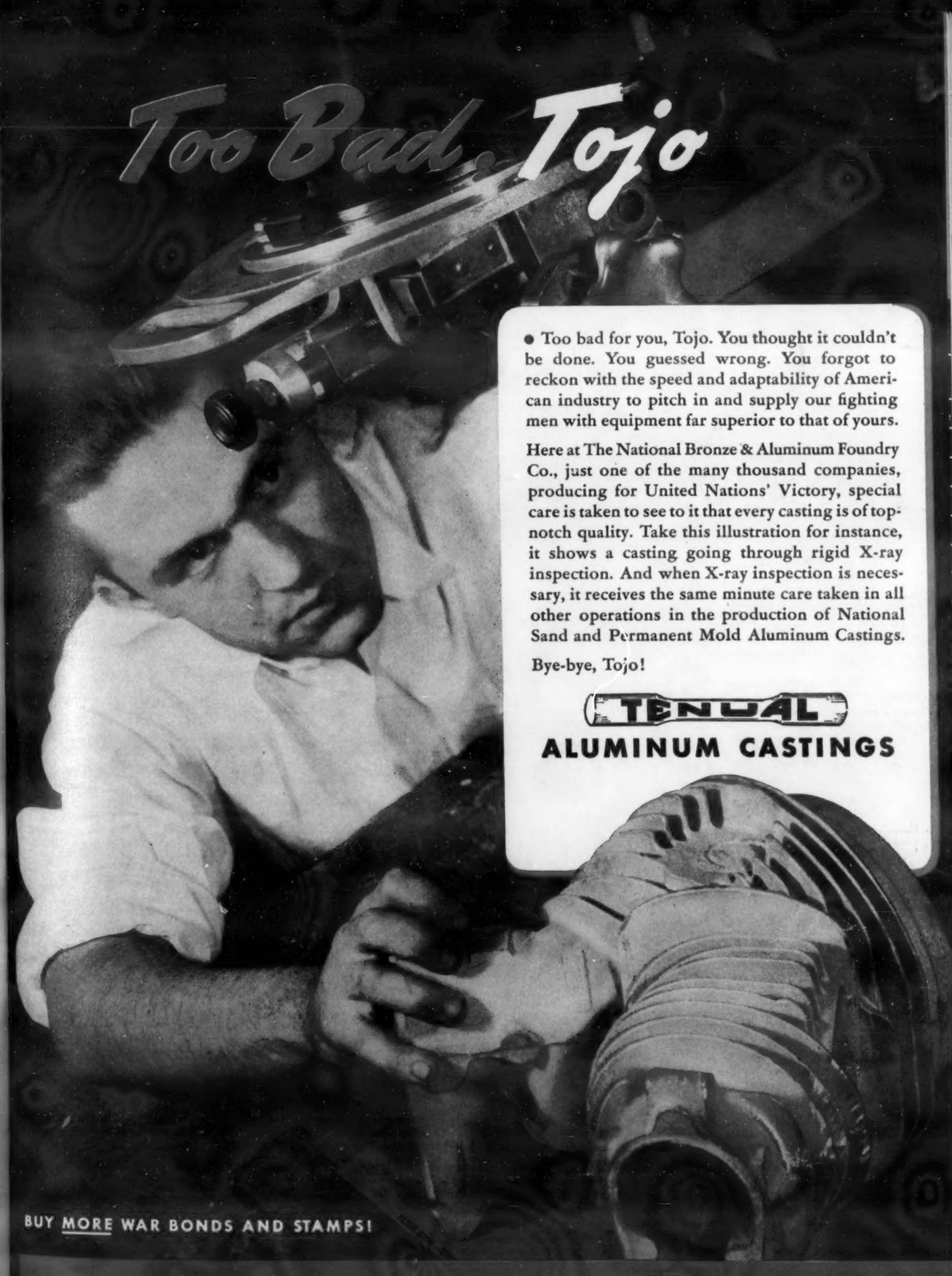
For Hollow Shafts

An analogous analysis as that outlined for solid shafts shows that the resilience of hollow shafts is equal to $(R_1^2 + R_2^2)f_s/4NR_2^2$ where R_1 is the internal radius and R_2 is the external radius. For very thin tubes where R_1 approaches R_2 as a limit, $\rho = f_s{}^2/2N$ for unit volume. It will be noted that this is twice the resilience of a solid shaft. This is because the stress on the outer fibres is higher than the average stress through a solid shaft.

Hence, depending on the wall thickness, the resilience of a hollow shaft for the same unit volume will be between 1 and 2 times the resilience of a solid shaft. Since the resilience of a hollow shaft, like a solid shaft, is still proportional to $f_s{}^2/N$, the ratio between the steel and the duralumin previously cited will be 1 (steel) to 1.55 (duralumin) for equal volumes.

The comparison on the basis of power-

Too Bad, Tojo



● Too bad for you, Tojo. You thought it couldn't be done. You guessed wrong. You forgot to reckon with the speed and adaptability of American industry to pitch in and supply our fighting men with equipment far superior to that of yours.

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Bye-bye, Tojo!

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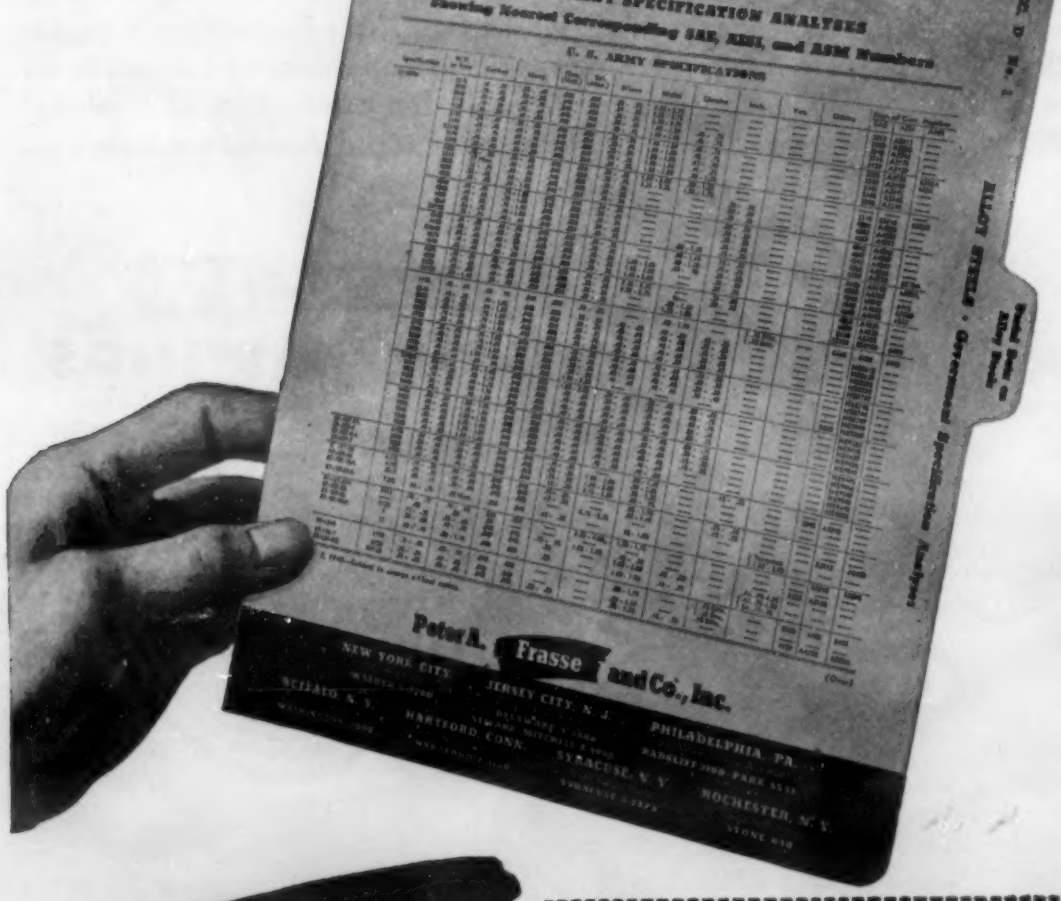

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carrying capacity depends upon whether the increase in thickness of the duralumin tube is obtained by increasing R_2 or decreasing R_1 or both. The horsepower transmitted for a given maximum stress is proportional to $(R_2^4 - R_1^4)/R_2$.

—Leslie P. Dudley, *Light Metals*, Vol. 5, Dec. 1942, pp. 497-500.

Oil-Corrosion of Bearings

Condensed from "S.A.E. Journal"

Twenty laboratories, coöperating in the program of the Bench Test Subcommittee of the S.A.E. Crankcase Oil Stability Research Committee, ran tests on 6 reference oils in Underwood apparatus, Lauson single-cylinder engines, and in a number of other types of laboratory oil test devices. The 6 oils used were the B-1, B-2, and B-3 oils from Subdivision B of the S.A.E. Lubricants Division, as used in standardizing the 36-hr. Chevrolet engine oil stability test, and the C-1, C-2, and C-3 oils from the Coöperative Fuel Research Fuels and Lubricants Advisory Committee, Chevrolet Engine Test Procedure Group.

In the coöperative work, each laboratory was requested to test the 6 oils following the test procedures each had used in the past. Standardized test conditions were not set up for any of the bench test methods.

The reference oils represent a good cross-section of the various types and varieties of motor oils on the market. B-1 is a 57-V.I. (viscosity index) oil, containing inhibitor and metal detergent additives. B-2 is a 106-V.I. oil with no additives. B-3 is a 100-V.I. oil, containing inhibitor and metal detergent additives. C-1 is an 88-V.I. oil, containing sulphur inhibitor compound. C-2 is a 92-V.I. oil, containing phosphorus inhibitor compound. C-3 is a 76-V.I. oil with natural sulphur content of 0.37 per cent and no additives.

Bearing Performance in Specific Oils

Based on copper-lead bearing corrosion in the 36-hr. Chevrolet engine tests, oils B-1, B-3, C-1, and C-3 are rated as being substantially non-corrosive to such bearings, while B-2 and C-2 are rated as highly corrosive.

The laboratories which ran Underwood tests used a considerable variety of test conditions. Results obtained on corrosion of cadmium bearings indicate that 10-hr. Underwood tests at 325 deg. F., with 0.01 per cent Fe_2O_3 as naphthenate, come the closest in rating the corrosion tendencies of the reference oils in line with the 36,-hr. Chevrolet tests. The single exception is the corrosive rating of oil C-3. This discrepancy may be considered of relatively minor importance since both the Underwood and the Chevrolet engine rate oils of the C-3 type as having limited oxidation resistance both as to sludge formation and acid formation. The essential difference seems to be that the oxidation acids formed are not corrosive to sensitive bearings in the engine but are active on bearings in the bench test.

There is a complete lack of agreement between the results of Underwood tests of

CHECK your use of forgings against these seven advantages that forgings offer

These 19 manufacturers obtain specific benefits from forgings

Manufacturer of	Uses Forgings for	Saving of Metal Effected	Reduction in Machining Time	Other Advantages Realized
Material Handling Equipment	Over 70 Parts	Yes	Yes	Fewer Rejects
Diesels	Flange	Yes	Yes	Welding Eliminate
Wire Strapper	Arms	50%	100%	No Machining
Elevating Truck	Sprocket	18 lbs.	Approx. 40%	Less Time
Pressure Valves . . .	Body	Yes	24%	Less Scrap
Collapsing Tap	Six parts	Yes	Approx. 10%	Less Scrap
Oil Valves	Body	Yes	Approx. 50%	Fewer Rejects
Chain Pullers	Well End	No	Approx. 20%	Inspection Time
Oil Equipment	Valve Body	No	Approx. 75%	Fewer Rejects
Motor Graders	Clutch Parts	No	Approx. 15%	Less Wear on Too
Axle Housings	Shift Lug	Yes	Approx. 750%	Saving Mach. Spac
Turret Lathes	25 Parts	Yes	Approx. 20%	Fewer Rejects
Automatic Lathes . . .	Gears	Yes	Approx. 80%	Less Scrap
Automatic Hoists . . .	Drum Sleeve	6600 lbs.	1200 man-hrs.	Fewer Rejects
Typesetting Machines	Vise Jaws	Yes	Approx. 35%	Less Time
Gears	Spiral Gear	19 lbs.	Approx. 20%	Less Time
Milling Machines . . .	Bevel Gears	Yes	Approx. 30%	Insp. Time Saved
Gear Sets	Pinion	App. 50 lbs.	Approx. 75%	Less Scrap
Industrial Trucks . . .	Diff. Case	Yes	Approx. 25%	Fewer Rejects

Evidence substantiating these advantages has been published in Drop Forging Topics.

The 7 advantages that forgings offer

1. **Forgings Conserve Metal:** Strength is a primary quality advantage of forgings. The metal bulk of many parts may be reduced because maximum tensile and torsional strength is obtainable in forgings through controlled grain flow and distribution of metal.

2. **Forgings Lessen Scrap:** In forgings it is possible to obtain uniformity of physical properties in the exact degree desired. Practically no rejections result. Heat treating forgings is a straight-forward production procedure, controllable at all times.

3. **Forgings Conserve Metal by Weight Reduction of Parts:** Reduction of dead weight is a common result of using forged parts because forging produces maximum strength in lighter sectional thicknesses, thereby permitting the use of lighter weight parts.

4. **Forgings Facilitate Rapid Assembly Through Welding Adaptability:** Forgings provide a welding adaptability of widest range for fabricating complicated parts from two or more forgings.

5. **Forgings Require Less Time to Machine and Finish:** Forgings are shaped in closed dies and require a minimum of machining or finishing because there is no bulk of excess metal to remove, and freedom from concealed defects avoids loss from rejections.

6. **Forgings Reduce Accidents to Men and Machines:** Freedom from concealed defects is an outstanding characteristic of forgings that underlies the greater margin of safety that forgings afford for men, machines and material.

7. **Forgings Can Take It:** By the forging process, stamina is achieved through concentration of grain structure and fiber formation at points of greatest shock and strain. Forgings provide high fatigue resistance which underlies dependable performance, and continuous operation over longer periods of use.

★ ★ ★ ★ ★

THE EXPERIENCE of 19 manufacturers who checked their use of forgings and identified the benefits obtained through forgings, suggests that a recheck of every forging part you use against the seven advantages that forgings offer, might reveal further opportunities to conserve critical materials, or indicate a faster method for machining and finishing forgings, or effect a reduction of scrap . . . Everyone in your plant who is responsible for designing, obtaining and finishing forgings should check your use of forgings against the seven advantages forgings offer. This checking need not be difficult or time wasting. Assistance is available from forging engineers connected with your source of supply. These men are well qualified by broad experience to help you obtain the fullest measure of benefits from forgings. Begin your checkup now!

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if the bonding isn't right!

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AMP Bonding Jumpers are made of an aluminum alloy wire produced by Callite specifically for this purpose. The low resistivity and high tensile strength of this wire are combined to produce a jumper of maximum conductivity and durability. If your job requires a wire of uniform high quality and stamina, specify Callite Wire. Callite Tungsten Corporation, 546 Thirty-ninth Street, Union City, New Jersey. Branch offices in Chicago and Cleveland.

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copper-lead bearing corrosion and the Chevrolet results. There is also a wide variation in the results reported by the different laboratories which used copper-lead bearings in their Underwoods. These facts indicate that in Underwood tests, cadmium bearing specimens must be used to secure information on corrosion tendencies of oils.

Correlation of Methods

While there was a wide variation in test conditions in the Lauson engine tests, the agreement regarding copper-lead bearing corrosion among the laboratories is quite good and the oils in the majority of the tests are rated in the same order by the Lauson engine as the Chevrolet engine. For evaluating accurately bearing corrosion tendencies in the Lauson engine, the oil temperature should not exceed 280 deg. F. and the test-time should be 100-120 hrs. If high coolant temperature is used, oil temperature should be lower.

MacCoyll corrosion tests appear quite similar in overall ratings to the Underwood tests. Correlation of bearing corrosion by strip corrosion tests and by the Chevrolet engine seems poor. Corrosion ratings by Sohio oxidation tests are not differentiated as well as they might be.

The series 30 Ethyl engine tests show essentially no difference in corrosion tendencies between the 6 reference oils. Babbitt bearings are probably used in this engine so that corrosion tendencies are not intended to be evaluated.

—C. W. Georgi, *S.A.E. Journal*, Vol. 51, Feb. 1943, Trans., pp. 52-62.

Plastics and Metals

Condensed from "Transactions," Am. Society of Mechanical Engineers

In order to get a much more accurate insight into the dynamic mechanical properties of materials than is possessed up to now, two new oscillatory-type testing machines were developed with which these properties can be studied under complete reversals of both direct stress and torsional stress; they permit also keeping a continuous record of the dynamic modulus of elasticity and to run complete fatigue tests. In this manner, experimental data on the damping capacity, dynamic moduli of elasticity and some static mechanical properties were obtained for mild steel, duralumin, grade X laminated bakelite, laminated-canvas phenolic, and methyl-methacrylate plastic.

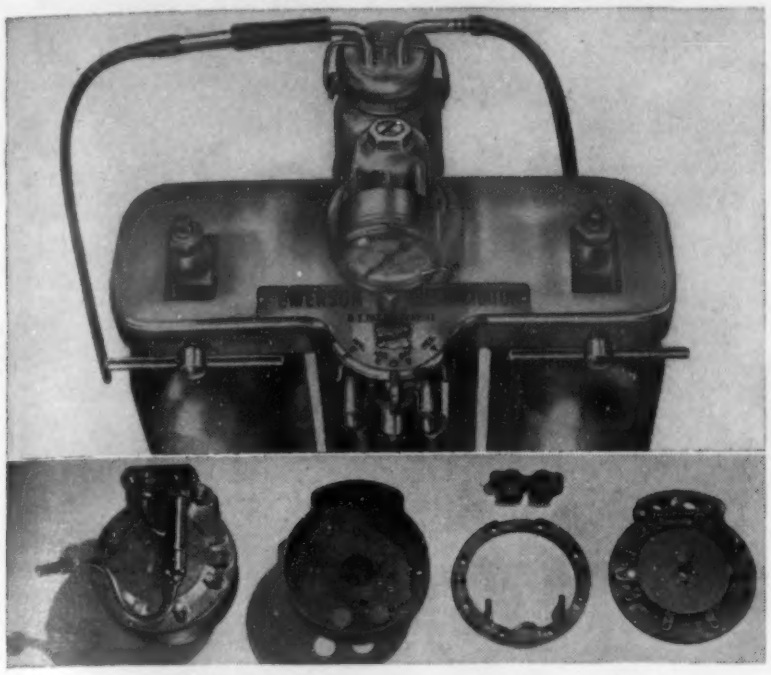
Where Plastics are Superior

The resonance amplification factor for the plastics tested was about 1/10 that of the metals. The stress induced by resonant vibrations in a structural member is proportional to the product of the exciting force and the resonance amplification factor. Therefore, structural plastics with a low fatigue limit (about ⅓ that of duralumin), and a much lower resonance amplification factor, may actually be more durable than metals in members subject to large vibration-exciting forces.

In some aircraft parts the superior vibration-damping ability and low density of

FOR WAR TODAY—FOR YOUR PRODUCTS TOMORROW

A DIE CAST HEART FOR MECHANICAL LUNGS



A resuscitator and its die cast heart assembly

Each of the many models of resuscitation units produced by a prominent manufacturer is equipped with an assembly of four zinc alloy die castings which constitute the "heart" of the breathing mechanism.

These castings, illustrated above, have a number of advantages over parts produced by other means. Their dimensional accuracy assures a "tight" assembly, they are complex in design to minimize machining and assembling costs, and they are tough enough to take abnormal abuse.

The latter point is important when one considers that these mechanical lungs are now seeing service with our armed forces in the field, as well as in civilian hospitals. The particular unit shown above can be converted — by a simple adjustment — into a resuscitator, an aspirator (drawing off throat secretions) or an inhalator.

QUESTIONS & ANSWERS ON DIE CASTINGS

What is a die casting? What is the rate of production in die casting? What shapes are possible in die casting? Is the die casting process applicable only to mass production?

If you want the answers to these questions, or if you have other questions on the subject of die castings, write for a copy of the booklet "Zinc Alloy Die Casting," just off the press.

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THE New Jersey Zinc ALLOY POT

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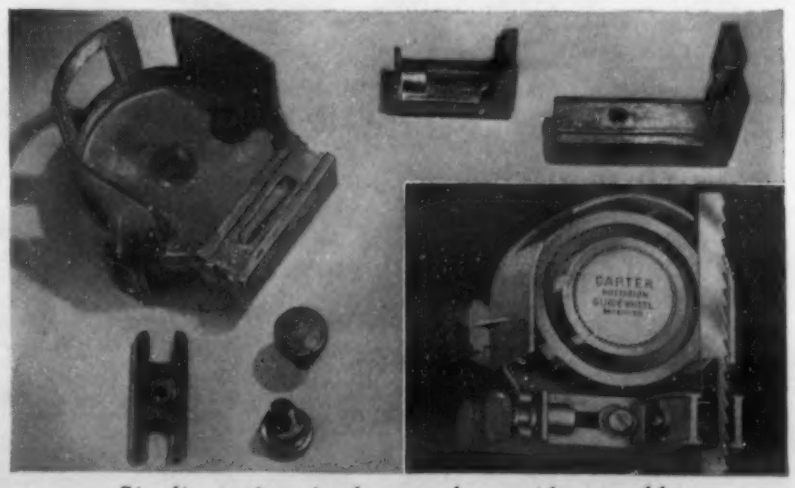
METALS AND ALLOYS EDITION **No. 8**

ALL-DIE CAST BAND SAW GUIDE

The versatility of zinc alloy die castings is clearly illustrated in the band saw guide assembly shown below. Everything is die cast except the guide wheel and a few screws. The manufacturer says:

"The design is such that had this been made in the usual way from rough castings and machined, the cost would have been prohibitive and the assembly would have been heavy and cumbersome. By die casting these parts the guide is very compact and very strong, but accurate for the work it has to do."

This guide can be assembled either right or left hand for use on any band saw above or below the table. It will operate on saws with a blade speed up to two or three miles per minute. A wide variety of war work is now being turned out with the use of this guide in shipyards, aircraft plants and other war industries.



Six die castings in the complete guide assembly

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plastics (about 0.5 that of aluminum and 0.18 that of steel) may make them an acceptable substitute for metals. Sustained cyclic stress below the endurance limit increased the resonance amplification factor of the metals tested as much as 25 per cent. Although the increase was rapid at first the resonance amplification changed very little after about 100,000 cycles of stress. A pronounced reduction in both the resonance-amplification factor and the dynamic modulus of elasticity occurred at impending fatigue failure in all materials tested. This reduction was usually evident before any macroscopic fatigue cracks could be observed.

Plastic Properties

For most of the metals tested the dynamic modulus of elasticity, under both direct and torsional stresses, decreased a few percent as the alternating stress increased. The dynamic moduli were within a few percent of the static moduli. For the plastics tested, the dynamic modulus of elasticity under both direct and torsional stresses decreased as much as 40 per cent as the magnitude of the alternating stress increased. However, the dynamic modulus at zero stress, obtained by extrapolating the experimental curves, showing dynamic modulus versus stress, was within a few percent of the static modulus.

Since the dynamic modulus of elasticity may deviate considerably from the static modulus, most repeated-constant-deflection types of fatigue machines do not give reliable results on plastics. The high damping capacity of plastics causes a large amount of heat to be developed within the specimen during the fatigue test. The resulting rise in temperature may greatly influence the mechanical behavior of the plastic. An appendix explains the theory of the machines and of the calculations involved.

—B. J. Lazan. *Trans. Am. Soc. Mech. Engrs.*, Vol. 65, Feb. 1943, pp. 87-104.

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Low-Temperature Fatigue of Steels

Condensed from "Archiv Eisenhüttenwesen"

Smooth solid rods and specimens with annular pointed notch of two chromium-molybdenum steels, one chromium-nickel-molybdenum steel, and three unalloyed steels with 0.08, 0.40 and 0.64 per cent C were subjected to tension-compression alternating tests with different average tensions at +20, —78 and —188 deg. C. (68, —108, —306 deg. F.) by the Wöhler method.

The results show that the Wöhler lines for the same material do not change at a definite temperature for different average tensions and run practically parallel. A difference occurs only in the inclined part of the lines (toward the abscissa axis). The border lines have, in solid smooth rods, an almost parallel course with decreasing temperature and only a slight decrease of the deflections with increasing average tension, while in notched rods, the deflections decrease considerably with increasing average tension.

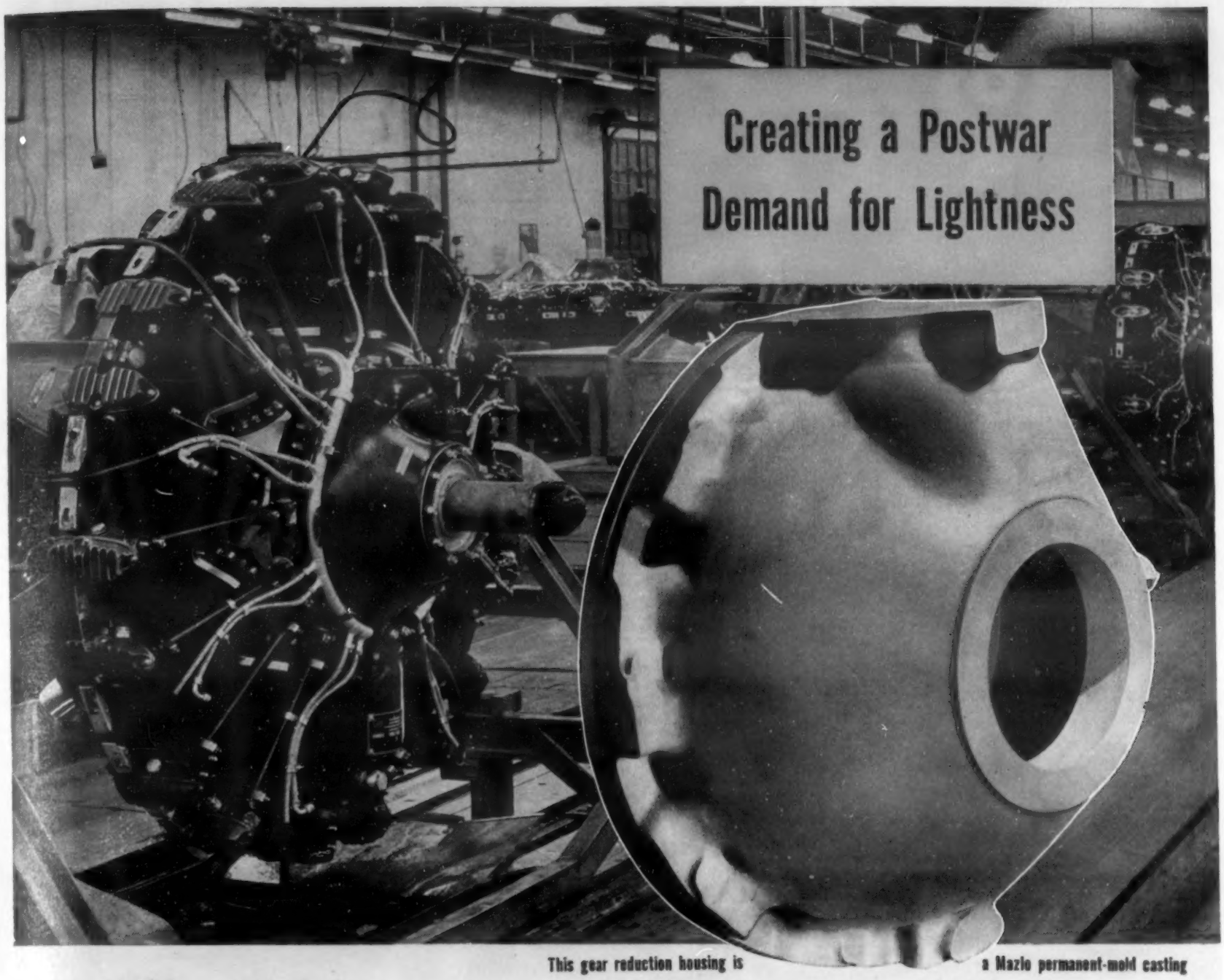
Alternating tests can be made on both solid and notched specimens at low temperatures up to much higher average tensions than at room temperature. Both fatigue strength and notch-fatigue strength increase with increasing tensile strength of the steels. The increase of fatigue strength of solid rods is especially noticeable in the temperature range from —78 to —180 deg. C. (—108 to —306 deg. F.) Notch-sensitivity of the unalloyed steels increases appreciably with falling temperature, especially at —188 deg. C. (—306 deg. F.) Complete diagrams illustrate the results.

—M. Hempel & J. Luce. *Arch. Eisenhüttenwesen*, Vol. 15, Mar. 1942, pp. 423-430.

Properties of Galvanized Coatings

Condensed from "Sheet Metal Industries"

While many people attribute the usefulness of zinc as a protective coating to its electrochemical position relative to iron, it is believed that the most important factor is the relative stability of the zinc itself.



This gear reduction housing is a Mazlo permanent-mold casting

Your designers may, for the first time, be turning to magnesium alloys, as they are called upon to save as much weight as possible in combat equipment. That, of course, is where all Mazlo Magnesium castings, forgings, sheet and shapes are going today. Plant men, too, are discovering the economies possible because of the high speeds at which magnesium can be machined. They are learning its fabricating techniques.

All of this experience will stand these men in good stead, as the present widespread use of magnesium alloys carries over into postwar production. "We made war materiel lighter with magnesium. Many peacetime products need that same dependable lightness."

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The importance of the purity of the zinc has been greatly overstressed in the past. Most impurities seem to increase the corrosion of the coatings, although cadmium and lead have been stated by some to be beneficial. However, under most conditions of exposure, impurities play a very small role in the corrosion of zinc.

The type of medium to which the zinc is exposed has a very profound influence on the corrosion. The effect of water on zinc is governed by the oxygen, carbon dioxide and salt contents of the water (some salts form protective films on the zinc). Stagnant water generally causes less corrosion than agitated water.

In the case of atmospheric corrosion, the humidity of the air is important, as is also the presence of sulphur dioxide in industrial atmospheres or chlorides near the sea coast. Heavy industrial atmospheres are particularly corrosive as can be seen from the following expected lives for galvanized sheet with 1 oz. per sq. ft. of surface of zinc:

Location	Life in yrs.
Rural	20-25
Sea Coast	15
Semi-industrial	10-15
Heavy industrial	6- 8

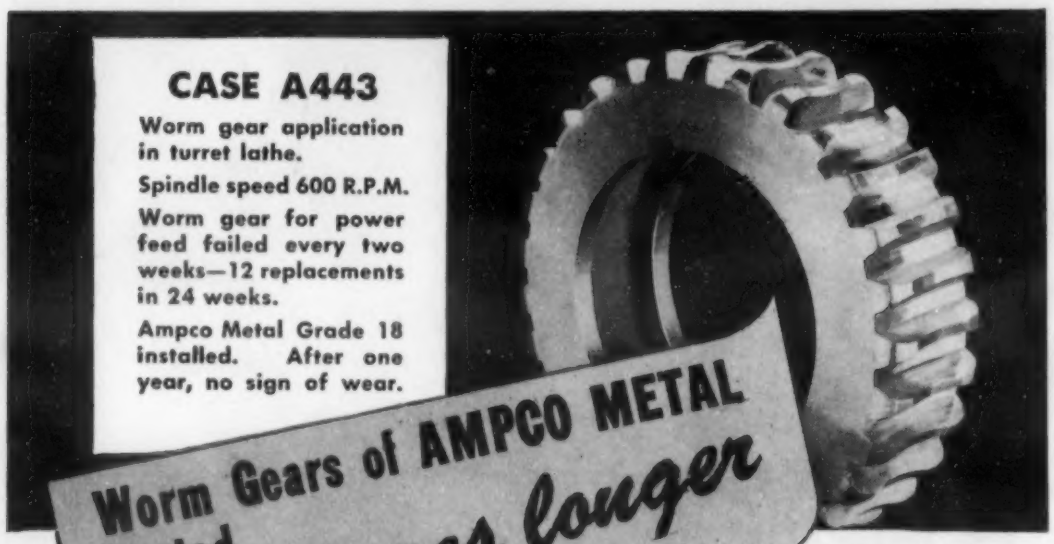
Rain is important because it washes away a large proportion of the corrosion product and also leads to the possibility of electrolytic corrosion. The nature of the coating on the zinc depends on the conditions of its formation and it is usually complex. If hygroscopic compounds such as zinc chloride are present, corrosion is rapid.

There are many instances where zinc is corroded electrolytically by the contact of a more noble metal with the surface of the coated article. Zinc is also susceptible to attack by differential aeration.

Although it is generally believed that heavy zinc coatings offer less protection than thin coatings because of the presence of more cracks, it has been found that heavy coatings are preferable even when cracking occurs.

The effect of temperature may be marked. For example, in distilled water, the corrosion loss was greatest in the range of 130 to 200 deg. F. as the corrosion product formed here was non-adherent. At lower and higher temperatures, an adherent film protected the zinc from further corrosion.

—"Galvaniser," *Sheet Metal Inds.*, Vol 16, Dec. 1942, pp. 1850-1856.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Worm gear application in turret lathe.
Spindle speed 600 R.P.M.
Worm gear for power feed failed every two weeks—12 replacements in 24 weeks.
Ampco Metal Grade 18 installed. After one year, no sign of wear.
Worm Gears of AMPCO METAL Lasted 26 times longer

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Ampco Metal is particularly well adapted for gear service. Its resistance to deformation under static or dynamic loading insures maintenance of original tooth contours. Freedom from scoring and galling insures the true bearing action of the worm against the worm wheel, and the resulting longer life.

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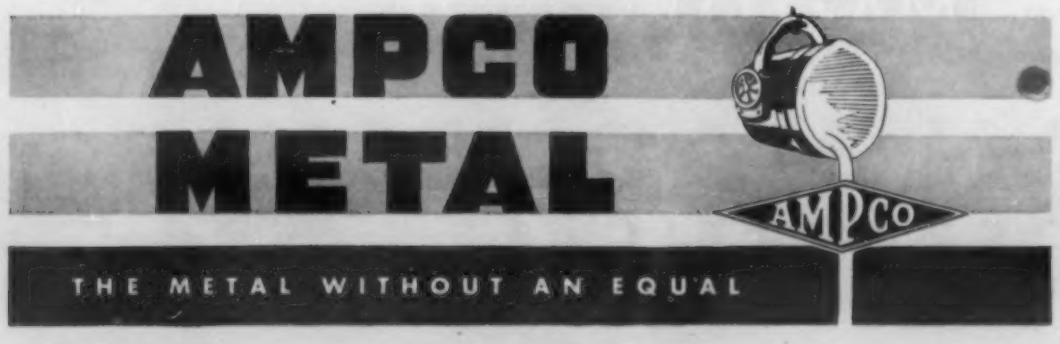


Fatigue Strength and Elastic Limit

Condensed from "Mitt. Kaiser-Wilhelm-Inst. Eisenforschung"

The various efforts to find a relation between the fatigue strength of a steel and its other mechanical properties are reviewed. No satisfactory results have so far been obtained; for practical purposes an approximation could be derived from the Wöhler test, according to which σ, (bending fatigue) $= 0.5\ \sigma$ (bending) for solid round rods.

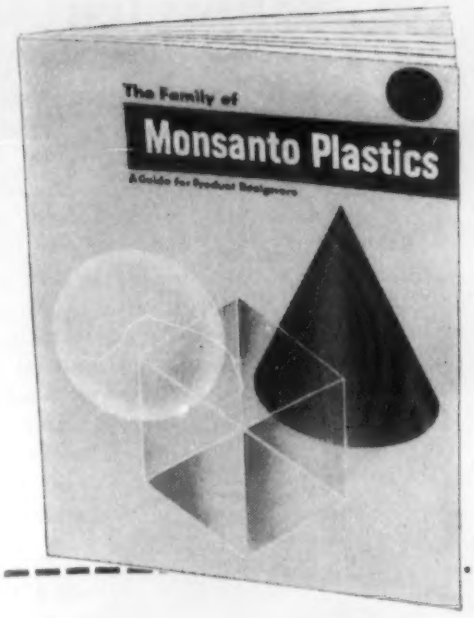
Experiments are described in which the effect of the ratio, elastic limit to ultimate strength, on the bending fatigue strength was investigated for four unalloyed steels and one chromium-molybdenum steel with 57,000, 85,000, 114,000, 142,000, and 170,000 p.s.i. ultimate strength.

Application of cold deformation for increasing the elastic limit (>0.90) does not increase the bending fatigue strength, but hardening under maintaining the ultimate strength of the cold-deformed material increased the bending fatigue strength considerably.

These results, combined with such from literature, show that in the range up to 142,000 p.s.i. ultimate strength, bending fatigue strength increases with increasing ratio of elastic limit for a material in the naturally hard, annealed or hardened state.

Materials which have greatly been strengthened by cold deformation or have been hardened to a higher degree as corresponds to their composition, do not show an increase in bending fatigue strength in spite of a high ratio of elastic limit. Steels with ultimate strengths of more than 142,000 p.s.i. fail to show any distinct effect of the elastic limit ratio on bending fatigue strength.

—M. Hempel & H. Krug. *Mitt. Kaiser-Wilhelm-Inst. Eisenforschung Düsseldorf*, Vol. 24, No. 7, 1942, pp. 97-103.



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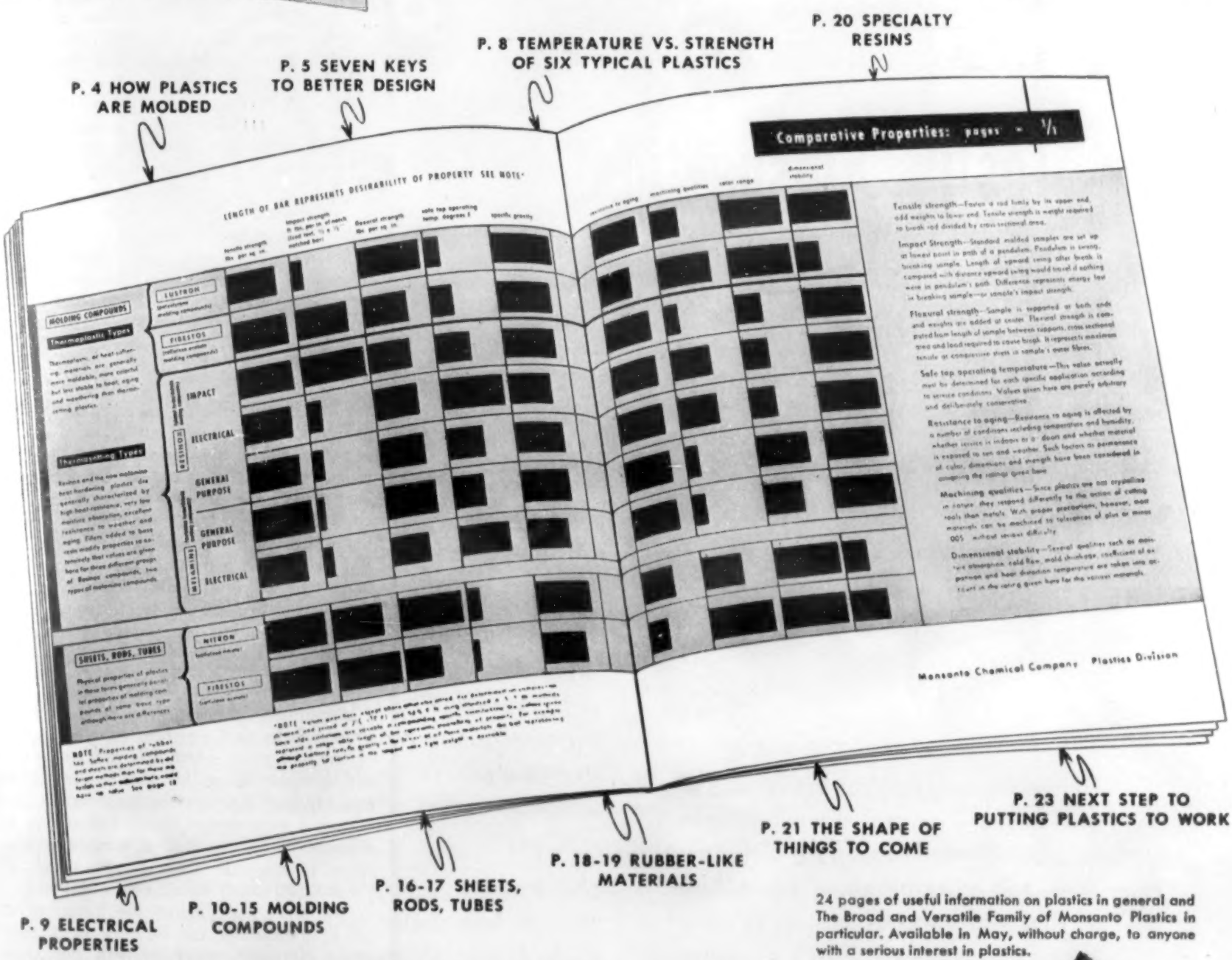

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CONTENTS

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Deep Drawing Tests

Condensed from "Light Metals"

It is generally recognized that there has been no widely used, recognized and accepted test for deep drawability of sheet metal. Lately interest has been aroused in this subject because of the recent work at the research department of the Lockheed Aircraft Corp. with the wedge draw test originated by Sachs.

This test, while closely simulating the stress conditions encountered in actual deep drawing operations, had not been sufficiently investigated and perfected to arrive at an exact appraisal of its value. The apparatus used at Lockheed is an improvement mechanically over the apparatus used earlier.

The Wedge-Draw Test

The test itself consists in pulling a wedge shaped piece of sheet metal through a corresponding shaped holder which has a cover plate over the strip to prevent wrinkling. Obviously the edges of wedge test pieces are subject to compression in the same way elemental sectors of a flat disc are when deep drawn through a die.

The larger the ratio of the radius of the circle drawn between the center of applied force and the outside end of the strip to the radius of the circle drawn from the same center to the throat of the test piece, R/r, the greater the drawability. The ratio as used by the Lockheed workers is usually written inversely, r/R; hence this ratio should be a minimum for high drawability.

The most obvious difference between the stresses encountered in the wedge-draw test and in actual drawing, is the lack of bending stresses in the former which are encountered in the latter as the blank is drawn over the die radius. However, the good correlation found between results of the wedge-draw test and actual deep drawing conditions, indicate this discrepancy to be of minor importance. Failure in tension in the wedge-draw test corresponds to failure by tearing sometimes observed in the wall of a drawn cup.

Behavior of Aluminum Alloys

Aluminum alloys in the harder conditions usually fail in shear in the portion of the test piece which has not yet passed through the throat of the holder. The shear failure is caused by combination tension and compression forces and results in slippage along the 45-deg. maximum shear stress planes. If shear failure occurs at about the same reduction with wedges drawn with and against the grain, as in 24ST, indications are that an actual cup given the same reduction will fail similarly.

On the other hand, if directional properties exist, and the r/R ratio is not too low for the directional sample most readily fractured, then drawing an actual cup will cause earing. Because the metal is under combined tension and compression forces, the deformation may be very high, as in extrusion and wire drawing. A drawn 24SO cup has been found to have a tensile deformation of 110 per cent in the flange just outside the drawn radius, or an elongation over nine times the guaranteed minimun under simple tension.

The variations in tensile and compres-

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sive stresses as the test proceeds are reflected in the change of thickness of the material, thinning at first, then no change, followed by thickening at the end of the draw. The effect of the hold-down load is not very important in relation to the other stresses present, but if high enough, the thickening of the material toward the end of the draw can be prevented by the ironing action.

Below a certain critical r/R ratio, tensile failure can not occur, but shear failure may be possible if the maximum shear stress exceeds the shear strength of the material. As other workers have found, the tensile test elongation is of little value in predicting drawability, regardless of the gage length chosen (down to 0.01 in.). Coarse grained 24S sheet was more drawable than fine grained which showed more pronounced directional properties.

—*Light Metals*, Vol. 5, Dec. 1942, pp. 314-320.

Studying Ingot Structures

Condensed from a paper for the Am. Inst. of Mining & Metallurgical Engrs.

Ingot structure is important in determining the quality of finished steel. Study of the structures of full-sized commercial steel ingots is costly. Small steel ingots have too rapid a freezing rate. Experimental models of non-ferrous metals and wax have been useful but limited in results. Silver chloride, however, has been found to offer several advantages as a material for models.

Properties of Silver Chloride

The shrinkage of silver chloride is comparable to steel, its melting point of 455 deg. C. (851 deg. F.) presents no difficulties, and its density is great enough so that several lighter materials can be stirred into the melt in order to study the distribution of "inclusions."

Silver chloride crystallizes in the simple cubic system, forming translucent to transparent crystals. When the molten salt freezes it forms polyhedral crystals similar to those exhibited by metals. The grain size, of the order of A.S.T.M. No. 1, is satisfactory for comparative studies with steel ingots. Freshly cast, it is white and almost transparent. The structure has an apparent relief effect permitting a ready location of regions of porosity, segregation, or concentration of impurities.

It may be extensively cold-worked and hot-worked if quite pure. The changes of hardness and density on annealing at increasing temperatures are similar to those for metals. Several samples, cold-rolled more than 50 per cent and annealed for 15 min. each at 200 deg. C (392 deg. F.), 325 deg. C. (617 deg. F.) and 485 deg C. (905 deg. F.) showed that recrystallization occurred with successively larger grains as the annealing temperature increased. A stress-free crystal is isotropic in polarized light, becoming anisotropic as stresses are imposed. Thus stresses may be studied by methods of photoelasticity.

With hot-worked silver-chloride it should be possible to study the effect of various forging practices as well as of various ingot structures on both the longitudinal and transverse mechanical properties of forgings. Addition of either silver bromide or silver iodide to silver chloride causes appreciably finer grain in the ingots. The somewhat greater photosensitivity of silver bromide as compared with silver chloride may be used to advantage in studying segregation.

Solid silver chloride was charged into an electric resistance furnace in weighed amounts. Dental investment-mix molds, having a silica base, thoroughly dried at 500 deg. C. (930 deg. F.), to prevent water vapor forming blowholes in the ingot, were made in shells of copper sheet. Hot tops were made from equal volumes of investment mix and Sil-O-cel. Four types of molds, with proportions similar to an available series of iron molds for pouring 170-lb. steel ingots were used. The melt was poured directly from a graphite crucible into the molds. After cooling, the cast ingots were split longitudinally, flattened with a file and repeatedly polished and etched.

Ingot Structures

Three series of ingots, (a) at 460 deg. C. (860 deg. F.), (b) at 520 deg. C. (970 deg. F.), and (c) at 510 deg. C. (950 deg. F.) were poured. The latter had 200-mesh graphite stirred in before casting. Comparison of the ingots of series (a) and (b) shows:

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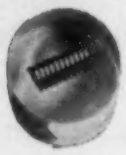
1315 AB Specimen Mount Press

1540-3 AB Multiple-Unit Polishing Table

Standard Bakelite Mount



Transoptic Mount

1500 AB Standard Polisher

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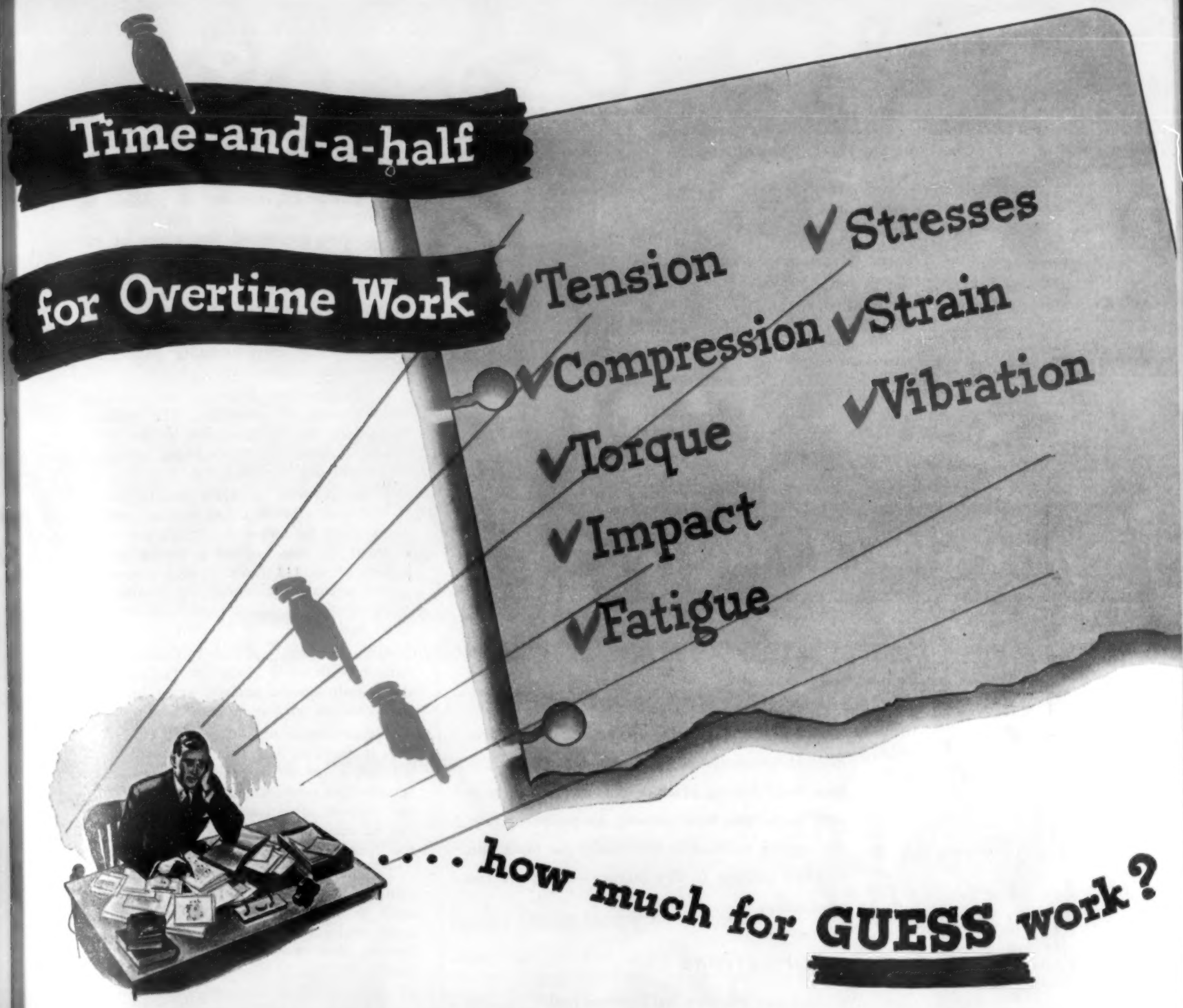
Adolph I. Buehler

OPTICAL INSTRUMENTS ★ METALLURGICAL APPARATUS

228 North LaSalle Street, Chicago, Illinois



. . . how much for GUESS work?

You know in advance the exact rate for overtime in your plant. But you can pay for overtime, and lose production at the same time if your testing equipment is obsolete.

One of the surest ways to take guess work out of your plant is to equip with modern Baldwin Southwark Testing Machines. Thus you can subject all materials to physical tests before you accept them—before they are fabricated into finished production.

Regardless of your requirements . . . of the materials you are using . . . there is a Baldwin Southwark Testing Machine to suit your needs. If you need help with your testing routine, Baldwin Southwark engineers can help you with the answers. They have had years of experience in solving testing problems throughout industry.

You can eliminate needless guess work from your production with Baldwin Southwark Testing Machines. Write for Bulletin 107 today. Baldwin Southwark Division, The Baldwin Locomotive Works, Philadelphia; Pacific Coast Representative, The Pelton Water Wheel Co., San Francisco, California.

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BALDWIN SOUTHWARK

Division THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa.

1. The depth of the columnar crystal is always greater in the ingots poured at the higher temperatures. Similar effects have been noted in steel ingots. At the lower temperatures there is a slightly finer grain in both the columnar and equiaxed grain regions. The columnar crystals slope slightly upward from the edge toward the center as in steel ingots.

2. A greater lack of uniformity of the equiazed grain size prevails in the big-end-down-ingot than in any big-end-up-ingot.

In series (c) where graphite was thoroughly mixed into the melt most of the non-metallics were eliminated, having floated to the top, since the particle size used was too large. However, some of the graphite was entrapped near the bottom of the ingot, where predominance of refractory types of non-metallics in steel ingots has been reported. Ingots cast in larger molds showed shrinkage cavities similar to those found in steel ingots.

—Karl L. Fetters & Margaret Dienes. *Preprint, Am. Inst. Mining & Met. Engrs.* T. P. 1570, Feb. 1943 meeting, 11 pp.

Resin Method of Yield Testing

Condensed from "The Engineer"

Occurrence of yield at the surface of structural or other members can be detected by the scale on the surface. This effect is enhanced by whitewashing the surface prior to testing. Whitewash flakes off with the scale and shows the yield more clearly.

A greater improvement is obtained by coating with resin. This not only indicates yield, but allows observation of Lüders' lines, the position of localized stresses, and permits a certain degree of stress analysis. This method is useful in the case of complicated stresses or elaborate structures, welded designs, etc. It can be used for practically every stressing problem at atmospheric temperatures.

It is important that the resin coating be as brittle as possible. The resin is applied in the dry condition by the application of heat; the resins being melted at about 140 deg. C. (285 deg. F.).

Large particles of scale should be removed with a brush. Any coating, such as paint, must be removed. If the test piece is small the best method is to dip it into a bath of molten resin. Large pieces are coated partially or wholly by heating the surface with a blow torch and coating them piecemeal.

Resin may be applied by rubbing the surface with solid resin, by dusting powdered resin on the surface, or by brushing the resin on in the molten state.

A temperature of 140 deg. C. (285 deg. F.) is suitable, but experience will form a better guide to the conditions than actual temperature measurement. If the surface is not smooth after coating, the blow torch can be run over the surface to smooth off the resin.

This method is most useful in the case of complex stresses. It is possible in certain cases to detect fine cracks in the resin at right angles to the axis of stress at lower stresses than would cause yield. These cracks are due to the elastic deformation of the steel and do not extend through the thickness of the resin. They are unlikely to be confused with the true Lüders' line cracks, which are generally inclined to the axis of stress and extend through to the surface of the resin and result in flakes of resin. The progress of yield over the surface can be clearly followed by watching the lines broaden, spread, and appear at different points.

This method is particularly useful in structures where the design is such that certain parts act as stress raisers, as the position of these parts will be indicated by Lüders' lines appearing before the general yield of the structure occurs. By comparing the magnitude of the load at which earlier Lüders' lines appear with that at which general yield is indicated the relative stress-raising factors can be evaluated.

Considerable use may be made of the fact that where Lüders' lines are present, the underlying material has not yielded. Thus test pieces, representative of the original condition of the material, can be cut from those parts of the structure which remain unstrained after testing.

—J. S. Blair, *Engineer*, Vol. 174, Dec. 4, 1942, pp. 454-456.

Spot Weld Tester for Aluminum Specimens

Designed to meet the requirements of Navy Aeronautical Specifications PW-6, this 5,000-lb capacity Spot Weld Testing Machine is ideal for aluminum weld specimens. Semi-portable, simple to operate, this rugged machine is well suited for rapid and accurate testing in the factory—right on the production line.

SPECIFICATIONS

★ An 8-inch precision dial indicates load.

★ Cylinder with 4-inch stroke located on top of machine.

★ Specially designed, self-aligning, spur gear operated, open face grips with renewable file faces.

★ Grips accommodate offsets in welded specimens from smallest gage to ¼-inch thick. No backing plates or liners needed.

★ Motor driven oil pump connected to ¼-hp motor in base. Requires 110 v., 60-cycle, single phase.

★ 18-inch diameter steel base, low center of gravity, facilitates hand moving of machine. Hoisting hook at top for crane handling.

★ Overall height 78 inches—total weight approximately 850 pounds.

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Division THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa.

METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

Steel Gears Made Without Machining

Production of steel gears without machining, now being applied to pinion gears of military vehicles, were scheduled to be explained at the meeting of the American Society of Tool Engineers at Milwaukee, March 25-27. Gears are forged or coined

on presses complete with gear teeth, the process being so accurate that the gears, even after heat-treating, are held to .001 in. The process was developed by tool engineers of *Timken Detroit Axle Co.*

Not only does this process eliminate practically all machining, but it also saves half of the steel normally needed per gear. In the accompanying photograph, R. R. Nathan, chairman, WPB Planning Committee, appears at right, with Willard F. Rockwell, Board Chairman, Timken Detroit Axle Co. Mr. Nathan holds a gear for army vehicles and the small steel billet from which the gear is produced to finished size in giant forging presses. Mr. Rockwell holds the same type of gear and the large blank from which such gears are usually machined.

Alumina Silicate Coating for Metals

"Armor-Vit" is a new coating for metals, which the *Chicago Vitreous Enamel Product Co.*, Cicero, Ill. states "holds high promise of being revolutionary." It is essentially an alkali alumina silicate, one source of which is a new ingredient—an oil-bearing halloysite from the only known deposit in the world.

After the application of Armor-Vit by ordinary spraying equipment or the dipping method, the curing treatment combines the ingredients of the coating into a hard, heat-resisting finish, insoluble in boiling water and highly resistant to most acids and alkalis.

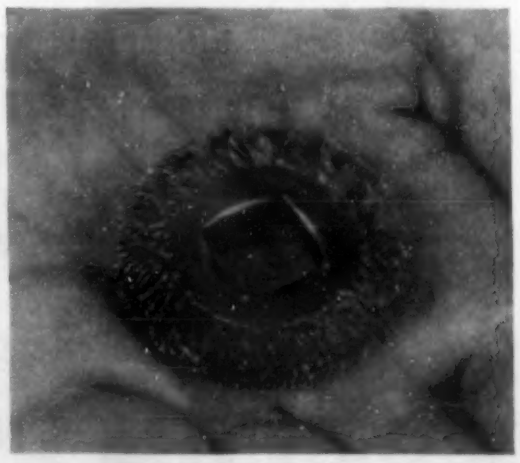
It has proved its ability to withstand the standard 200-hr. salt spray test, extended weathermometer tests and acid and alkali tests. Applied to steel test plates, it has been heated to 1200 deg. F., then quenched in cold water without coating failure. Suggested applications are field kitchens, gun mounts, marine hardware, helmets, tool and spare parts boxes, etc.

Wire Brushing Wheel Removes Rubber

A wire brushing wheel, slightly larger than a silver dollar and containing .014 in. steel wire, cleans out the rubber that flows over into the holes of tractor treads on General Sherman tanks when the metal and rubber are vulcanized together. The brushing wheel was made by the *Osborn Mfg. Co.*, 5401 Hamilton Ave., Cleveland.

Previously, removing the rubber was a tedious hand operation, the rubber adhering strongly. The wire wheel has a diameter equal to the inside diameter of the pin hole. The wire is coarse enough to remove the rubber, but not to mar the metal, and the job is done in about 1 sec.

It has other applications, such as re-



moving rust, welding scale or burrs made by the boring of holes that intersect the holes being cleaned. The wire is locked in by a one-piece ring and sleeve, which reduces breakage and creates a dense brushing surface.

● A comprehensive midget cutter gage has been brought out by *Severance Tool Industries*, Saginaw, Mich., and is free for the asking. It is printed on heavy cardboard in two colors and provides for accurate measurements for tool diameters, radii, number of teeth per inch, angles of cutter teeth, decimal equivalents, recommended operating speeds for milling cutters, etc.

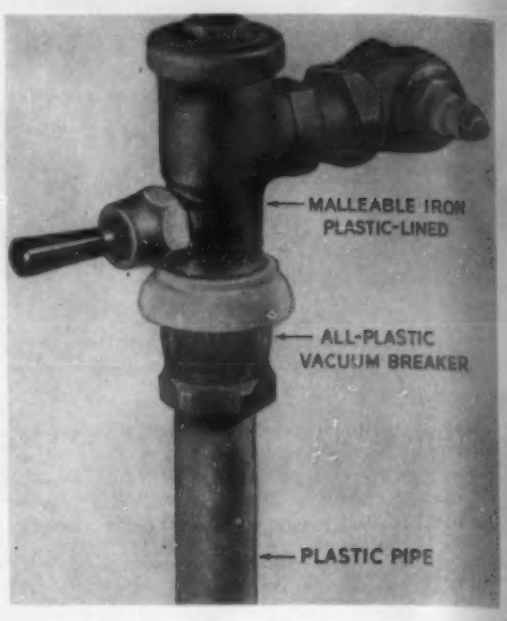
Plastics-Iron Toilet Flush Valves

An interesting case of substitution to save critical materials involves a toilet flush valve whose copper content has been reduced from 6 lb. to under 4 oz. per valve. A reduction of 2½ lb. per valve in shipping weight has resulted. The *Sloan Valve Co.*, Chicago, the originator in collaboration with the *Chicago Molded Products Co.*, reports that plastics and malleable iron replaced the more critical brass.

The new valve has withstood accelerated-time tests equal to 10 yrs. normal service without repair or adjustment. Over 225,000 installations in the field have given good service.

The valve body was of malleable iron with a plastic sleeve lining, the iron giving strength against sudden pressures and the plastic being anti-corrosive. The most vital part, the piston that regulates the amount of water passing through, is of plastics and of fewer parts than the original.

Other plastic parts are the vacuum breaker, handle, handle bushing, handle plunger, auxiliary valve, elbow flushing connection, bumper ferrules, and regulating screw bushings. The flush valve cover, control stop body and coupling nuts are made of malleable iron.



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99.99+% pure

The electrolytic refining process, originally conceived for the treatment of complex lead-zinc ores, consistently produces zinc of the highest purity. 42282

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● Surbrite is a new steel surface conditioner, made by *Hanson-Van Winkle-Munning Co.*, Matawan, N. J. It is an inhibitor and surface brightener for sulphuric or muriatic acid pickles, and reduces acid fume annoyance. It comes in "H" and "S" forms.

Explosive Rivets Fired by Radio

Radio frequency energy now is used to detonate explosive rivets and speed aircraft production, it is announced by *E. I. duPont de Nemours & Co., Inc.*, Wilmington, Del. The radio unit assures instant control of temperature in the firing tip, eliminating time consumed in heating an electric iron to operating degrees and in frequent changes from one tip temperature to another. It supplies only to large-scale production.

The radio unit, in whose development Radio Corp. of America cooperated, consists of an oscillator, together with a specially prepared applicator, to concentrate current directly into the rivet head. As current is induced in the head, the heat it creates fires the charge. The radio energy gives instant temperature control and prolongs indefinitely the life of the firing tip, which is always cool.

Explosive rivets are two years old. The makers claim they can install 15 to 20 per min., as against 2 to 4 for most "blind" fasteners.

● All users of ammonia are urged by WPB to speed the return of their empty cylinders to the manufacturers because steel is not available for new cylinders. Large quantities of anhydrous ammonia now are needed by the metal-treating trades for the manufacture of ordnance, these being coupled with normal demands of ammonia for refrigeration.

Light, Medium and Tanks have FORGINGS BY STANDARD

War being the supreme test of materials and workmanship, it is again proving that Standard's reputation for dependable steel products, gained in time of peace, and other wars, is well deserved.

With its roots implanted back in 1795, in the beginning of our Nation's history, Standard is today using the accumulated knowledge and experience of the intervening years to produce highest quality forgings and castings for equipment of our armed forces on land and sea, for war-time industry, and for the railroads.

The metallurgists and other trained personnel of Standard are acquiring added skill in meeting war-time demands that will be applied to industrial and transportation problems in the post-war period wherever quality steel forgings are required.

STANDARD STEEL WORKS

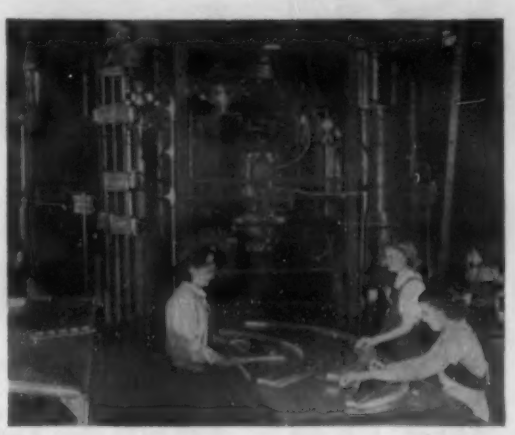
DIVISION OF THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA

FORGINGS • CASTINGS • WELDLESS RINGS • STEEL WHEELS

Big Press Well Operated by Women

One of the largest metal-working machines, the press, can be worked easily by women and with but little training, according to *E. W. Bliss Co.*, 53rd St. and 2nd Ave., Brooklyn. This is the Bliss Hydro-Dynamic 2500-ton six die slide aircraft press, which provides fully automatic safety interlocked control.

It has fully automatic operation by push button, with independent control of pressure on each station and with the interlocks eliminating the necessity of a master operator. It permits the heavy slides to be moved in and out of the press with ease and smoothness. There is no laborious work of locating die slides or re-arranging work within the press.



Coolant System for Band Saws

A new coolant system for horizontal band type saws has been brought out by *Gray-Mills Co.*, 213 W. Ontario St., Chicago. It is claimed to increase production as much as 150 per cent.

Model S-20 is designed to fit all types of horizontal band saws. It has an ample pump mounted in a coolant return pan, which, in turn, is attached below the saw to the legs. An unusual feature is the oil feed tube, which is slotted to fit the saw blade, assuring a full distribution of oil over the blade.

● When a lacquered steel cartridge case is rejected due to a defect in the lacquer, the complete removal of the coating becomes a problem. *MacDermid, Inc.*, Waterbury, Conn., has devised a method that eliminates several previous difficulties. It employs a low concentration alkali operating at or near the boiling point. The cases are dipped into this for a short time. Then they are rinsed and dipped in a non-proprietary solution that removes the last traces of lacquer and furnishes rust protection until the parts can be reprocessed.

Metal Sprayer for Wood Patterns

Wooden core boxes and foundry patterns can be sprayed with a low-cost, low-fusing alloy, which gives a relatively hard surface when finished, thus prolonging the life of the patterns, or, in the case of worn patterns, completely renewing them. The portable equipment is called Alloy-Sprayer, and is made by the *Alloy-Sprayer Co.*, 2040 Book Bldg., Detroit.

The thickness of the coating is usually from .002 to .005 in. If the wood surface is soft or open-grained, the metal can be sprayed directly; if the wood is hard and close-grained, a coating of shellac is applied, the spraying being done while the shellac is "tacky." The dried coating is sanded down to the desired finish.

The equipment is an electrically heated, thermostatically controlled, metal melting pot, with a gun handle for compressed air pressure control.

● A new precision grinding wheel of open, cellular construction (No. 15 abrasive content) is announced by *American Emery Wheel Works*, Providence, R. I. Its porous nature gives plenty of chip-clearance and space for air cooling to cut hardest alloyed steels without loading or "burning." Deeper cuts can be taken faster and with good finish. In wet grinding it carries extra coolant.

you can join your metal parts
ECONOMICALLY, NEATLY,
SECURELY and CONTINUOUSLY
By the ELECTRIC FURNACE BRAZING METHOD

The assemblies are loaded on a conveyor at charging end of the furnace as shown below

... and carried through the furnace and discharged—securely joined—clean and bright

FUSE adaptors for bombs; army truck parts and miscellaneous other products ranging in size from small intricate assemblies weighing only a fraction of an ounce up to large assemblies weighing several pounds are neatly and securely joined in numerous designs of continuous and batch type copper brazing furnaces—built by The Electric Furnace Co., Salem, Ohio.

Four E F copper brazing furnaces are shown on this page—the two pusher type furnaces shown above are brazing miscellaneous large and small assemblies. The two belt conveyor furnaces at left are brazing hubs into fan pulleys. Other types of E F brazing furnaces are handling practically everything from small metal radio tube parts up to large assemblies weighing 50 pounds or more.

Investigate the copper brazing process for your products. We will be glad to give you complete information, put samples of your products through one of our furnaces to show you the results you can expect, and give you an estimate on the cost of the equipment to handle your production, together with operating costs, etc.

Send for circulars showing other E F Copper Brazing Furnaces

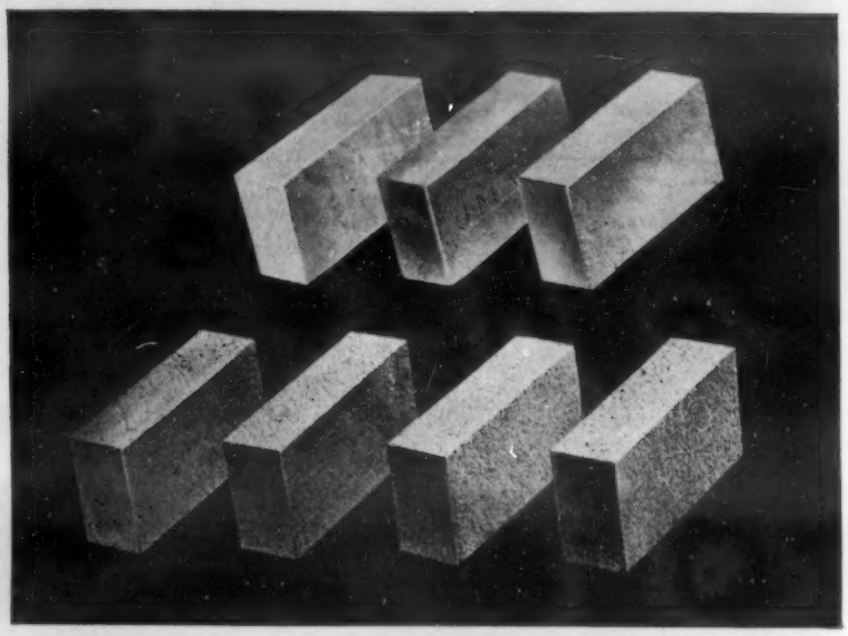
The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

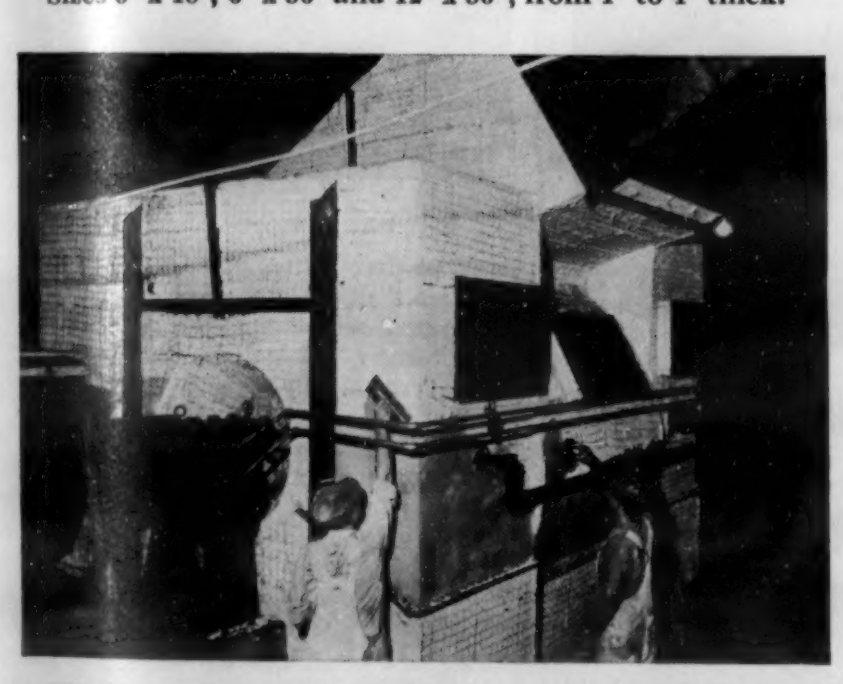
Meet wartime conservation demands with

Johns-Manville Insulations

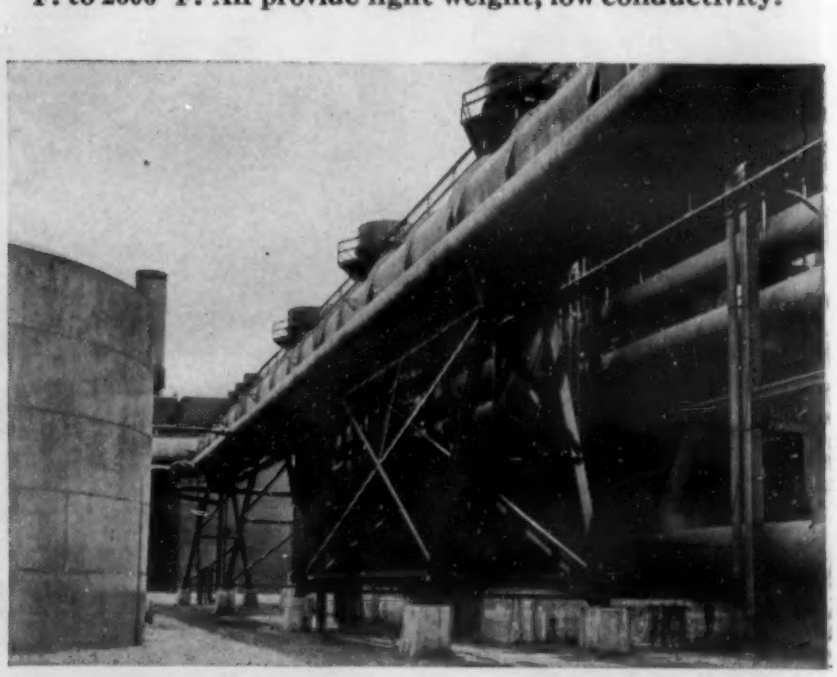
INSULATION FOR TEMPERATURES TO 1900° F. J-M Superex Blocks have long been standard for this service. High heat resistance, low thermal conductivity. Sizes 3" x 18", 6" x 36" and 12" x 36"; from 1" to 4" thick.



FURNACE INSULATION UP TO 2600° F. J-M Insulating Brick and Insulating Fire Brick are available in 7 types, with temperature limits ranging from 1600° F. to 2600° F. All provide light weight, low conductivity.



POWER PLANT INSULATIONS. J-M 85% Magnesia has been for many years the most widely used block and pipe insulation for temperatures to 600° F. and, in combination with Superex, for higher temperatures. Maintains high insulating efficiency. Standard block sizes 3" x 18", 6" x 36" and 12" x 36"; from 1" to 4" thick.



FOR STEAM LINES UP TO 700° F. J-M Asbesto-Sponge Felted Pipe Insulation is recommended where maximum efficiency, high salvage and resistance to abuse are essential. For temperatures over 700°, used in combination with Superex. It is available in 3-ft. lengths, from 1" to 3" thick, for standard pipe sizes.

JOHNS-MANVILLE

Industrial Insulations

FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE

FOR DETAILS on these materials, and on the complete J-M Insulation line, write for Catalog GI-6A. Johns-Manville, 22 East 40th Street, New York, N. Y.

JM PRODUCTS

Underwater Resistance Welding on Copper

Underwater resistance welding has replaced many soldering or brazing processes whereby copper cable is fastened to terminals at the works of *Westinghouse Electric & Mfg. Co.*, East Pittsburgh. This has raised output and improved quality. Special tips are used and a stream of water is played on the stranded wire near the electrode in sufficient volume to cool the work and prevent oxidation at the weld.

Electrode tips as now used are made of carbon, molybdenum and cupaloy. Increased tip life is obtained by mounting them in water-cooled holders. For welds that do not require flux, cupaloy tips with molybdenum inserts are satisfactory. Carbon tips are needed where flux is used. Inserts that contact the wire are grooved to prevent flattening the cable.

The operator lowers the upper electrode with a foot pedal to complete the weld. The machine is air operated and timed by electronic controls, which insure a quality weld.

● Electronic high frequency induction heat has succeeded gas heat in the soldering of crystal units used to maintain frequencies in war-radio equipment made by *General Electric Co.*, Schenectady. With gas ring burners, the crystals sometimes suffered internal distortion and there were injurious effects due to the products of high temperature gas combustion. But with the vacuum tube oscillator, these difficulties have been largely overcome.

Electronic "Ray Guns"

Pictures of bullets as they crash through steel armor plate are secured by electronic "ray guns," in the form of 300,000-volt X-ray tubes, used by the Army. Inside the tubes a withering fire of tiny elec-

trons produce a tremendous surge of X-radiation that will make a picture in a millionth of a second.

In industry, the machines make possible the study of rapidly moving machine parts. L. F. Ehrke, *Westinghouse* research engineer, is shown in the accompanying photo examining an unfinished tube.

Two New Carbide Tool Grinders

Two new belted-type carbide tool grinders have just been announced by *Hammond Machinery Builders, Inc.*, 1646 Douglas Ave., Kalamazoo, Mich. The first of these is the 4-B combination chip breaker and cup wheel grinder, fitted with the Multi-V belt drive, with which there are no electrical specification limitations and which dampens any motor vibrations.

A unique Any-Angle-Vise is one of the outstanding features. It is of double cradle design which, upon setting, can be instantly locked into one rigid piece with thumb levers.

The second, 6-B carbide tool grinder, is a machine that provides cup wheels on both ends and also has large 8x14 in. surface ground tilting tables.

1ST CHOICE *in the* AIRCRAFT *Industry*

Typical of DEMPSEY installations for the Nation's leading industries . . . . this aluminum melting furnace installed at Buick Motors Division of General Motors

MORE ALUMINUM for Aircraft Engine Castings and extruded parts passes through DEMPSEY FURNACES than all other types of furnaces combined

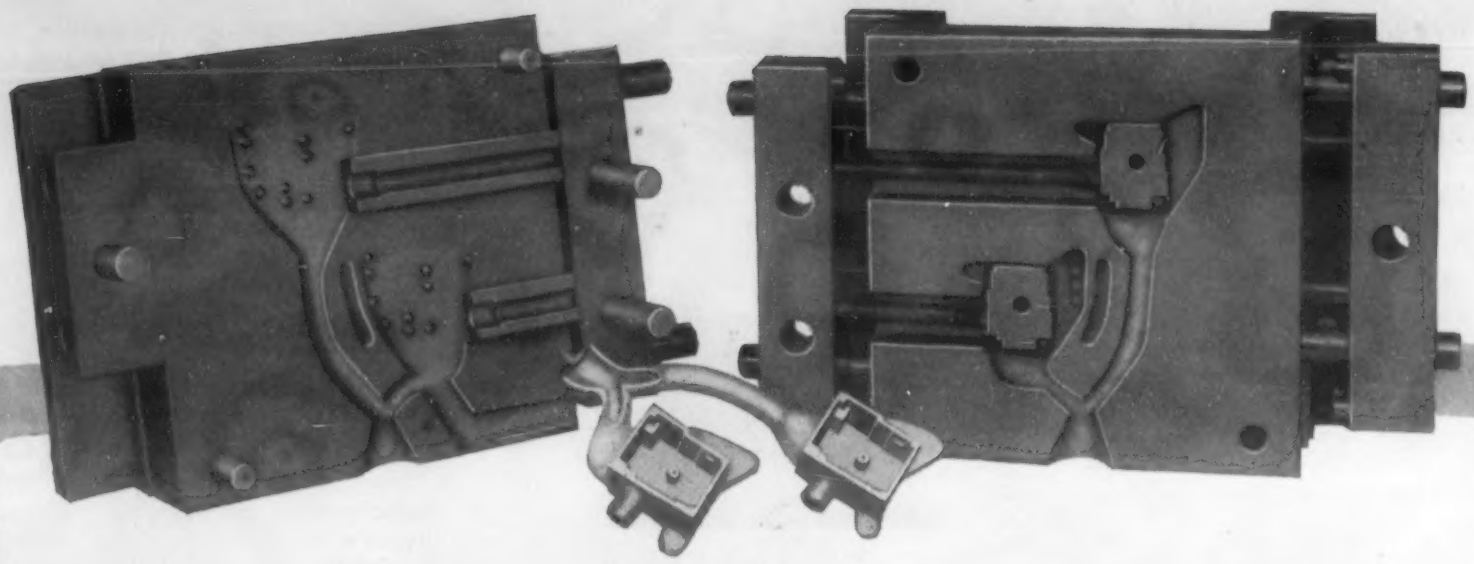
FASTER Melting Time • Simple Single Valve Control • Easy Control of Tapping Speed • Special Metal Saving Models for Chip Melting • Sturdy Long Life Construction • Oil, Gas or Coke Fired.

These are some of the reasons why DEMPSEY furnaces are such an overwhelming choice for aluminum melting . . . these, plus the valuable reservoir of experience offered by DEMPSEY engineers and the fact that speed of installation is assured by the wide variety of types and sizes, the plans and patterns for which are *now ready*.

Write for literature on these and DEMPSEY Furnaces for Recirculating, Homogenizing, Pre-heating and Heat Treating

DEMPSEY INDUSTRIAL FURNACE CORPORATION
SPRINGFIELD, MASSACHUSETTS
FURNACES—OIL & GAS BURNERS
Offers Combined 50 Years' Experience Building:
DEMPSEY FURNACES since 1917 • GILBERT & BARKER since 1908

DEMPSEY FURNACES



150,000 aluminum castings and still Good!

...With JESSOP DICA-B Hot Work Steel

The above dies made of Jessop's Dica-B Hot Work Die Steel and used in aluminum die casting have run 150,000 casts without heat checks of any kind — and they're still in top working condition! Metal has been run in these dies at 1350°F under an air pressure of 475 pounds; and yet they show no signs of deformation.

Dica-B, especially designed for die casting of aluminum and aluminum base alloys, is capable of withstanding alternate heating and cooling without fire cracking. It is highly resistant to abrasion and to the corrosive action of aluminum. Write for complete information.

APPLICATIONS

- Die Castings of Aluminum and Aluminum Base Alloys
- Drop Forging Dies
- Extrusion Press Liners
- Extrusion Rams
- Forging Dies in General
- Header Dies
- Hot Press Dies
- Gripper Dies
- Punches including Piercing
- Shear Blades
- Dummy Blocks for extrusion insert dies in upsetters

JESSOP STEEL COMPANY

HEAD OFFICE AND WORKS

Washington, Penna.

Est. 1901

WAREHOUSES:
CHICAGO • HARTFORD • CINCINNATI • CLEVELAND • DETROIT

Furnace for Carbon, Sulphur Determination

A new high temperature laboratory combustion furnace, the Glotemp, for use in rapid carbon and sulphur determination of ferrous and non-ferrous metals is announced by *Harry W. Dietert Co.*, Detroit. Its main feature is the short overall length of the furnace without sacrificing the efficiency of the combustion zone.

The Globar heating elements are at right angles to the axis of the combustion tube. Thus, the exposed ends of the heating elements and the electrical connections do not take up space along the axis of the combustion tube. Consequently, the carbon and sulphur determinations are quickly speeded up.

Both ends of the combustion tube are fully exposed to the room atmosphere, insuring efficient cooling of the tube ends to a low temperature, avoiding oxidation of rubber connections.

● Didymium-Noviweld is a new eye-protection glass that permits eyes of gas welders to see welding operations throughout. It is made by *American Optical Co.*, Southbridge, Mass. It cuts down the high intensity sodium rays of the fluxes and can look right through the yellowish cloud of "flux flare." It is particularly good in flame welding of aluminum and steel. The lenses also protect eyes by absorbing the harsh ultra-violet and infra-red rays.

Above: Oven for baking finishes, aluminum ageing, stress relieving. Temperature range up to 600°F.

At Right: Model R Convection Furnace for fast, economical heat treating. Temp. range up to 1750°F.

MORRISON ENGINEERED

TO MEET SPECIFIC NEEDS

The reason so many tough jobs go to Morrison is because sound engineering is the basis of every Morrison Engineered furnace, oven and melting pot designed and built to meet the user's individual requirements. And the same engineering experience stands back of every piece of Morrison standard equipment.

Send us your inquiries and take advantage of the accumulated experience of many years.

MORRISON ENGINEERING CORPORATION
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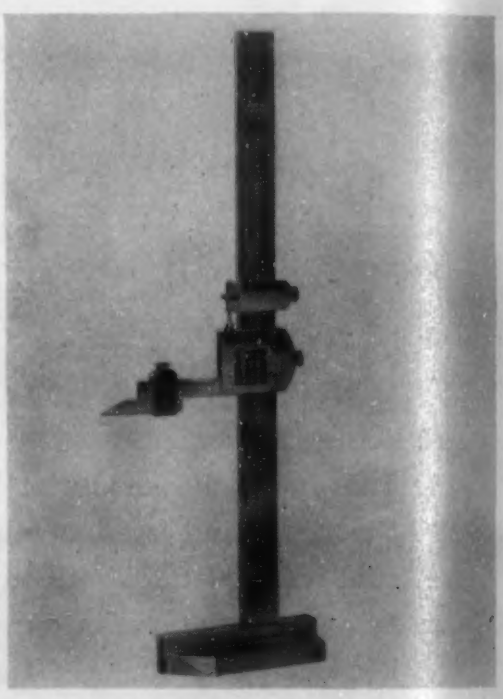
Associate Companies: MORRISON ENGINEERING OF CANADA, LTD. TORONTO, ONTARIO — CARRIER ENGINEERING CO., LTD. LONDON, ENGLAND

Gage for Jigs and Fixture Making

A vernier height gage in three standard sizes, 12, 18 and 24 in., English or metric measure, is announced by *Jansson Gage Co.*, 19208 Glendale Ave., Detroit.



It is designed for use in jigs and fixture making, and for general layout and inspection work. Exceptional precision enters into their calibration.

● Special-purpose machines in the form of spot welders and line welding machines used for refrigerator unit manufacture have been converted to incandescent brazing by *General Electric Co.*, Schenectady. The following three changes were made: (1) A switch was installed in the controller box for a continuous flow of power without the drive motor; (2) standard spot-welding electrodes were replaced by dummy electrodes drilled and tapped at one end where copper blocks are attached for the water-cooling supply and return; (3) to these copper blocks were attached large water-cooled leads and brazing tongs.

McKAY ELECTRODES SPEED PRODUCTION

IN EVERY WAR INDUSTRY

War and *necessity* are one . . . and necessity is the "mother of invention."

When war demanded new conceptions of production, *revolutionary applications of welding* were "invented" to meet the need.

In no small measure McKAY Shielded-Arc Electrodes contribute to the total accomplishment.

For it is only natural that a manufacturing policy, which merited the title "the researched line," should likewise rise to meet the requirements of this emergency. Thus new analyses, new coatings, new sizes, new ranges of adaptability . . . plus ever growing volume . . . have caused McKAY Electrodes to help speed production in every type of war industry.

THE McKAY COMPANY · PITTSBURGH, PA.

PACIFIC COAST SALES OFFICES: 125 S. Santa Fe Ave., Los Angeles · 100 Howard St., San Francisco

The McKay line includes regular carbon steel, stainless, and alloy steel electrodes for every welding purpose. Literature on request.

Among the first honored with the Navy "E", The McKay Company is proud of the broader award of the Army-Navy "E".

McKAY WELDING ELECTRODES

AND INDUSTRIAL, MARINE AND AUTOMOTIVE CHAINS

"KEEP ON BUYING U. S. WAR BONDS"

OXYGEN FREE HIGH OFHC CONDUCTIVITY

REG. U. S. PAT. OFF.

A SUPERIOR COPPER FOR ALL PURPOSES

OFHC Copper conforms to the A.S.T.M. Specifications for electrolytic copper wirebars, cakes, etc., B5-27 with regard to metal content and resistivity, and is free from cuprous oxide.

OFHC Copper is characterized by its freedom from casting defects and its bar-for-bar uniformity. Its freedom from oxygen results in great ductility and toughness as evidenced by its high reduction of area and resistance to impact. OFHC Copper withstands more working in hard condition when tensile strength is greatest, making it especially suited for products subjected to severe fabricating or service conditions.

THE AMERICAN METAL COMPANY, LTD.
61 Broadway, New York, N. Y.

HARDNESS TESTER *for* SOFT METALS *and* PLASTICS

The IMPRESSOR is a small, easily-carried instrument which is extremely convenient to use. By simply pressing the spring-loaded indentor point against the surface, the relative hardness of the material is immediately indicated on the dial. Comes packed in a fitted case, as shown below, appropriate for carrying or storage.

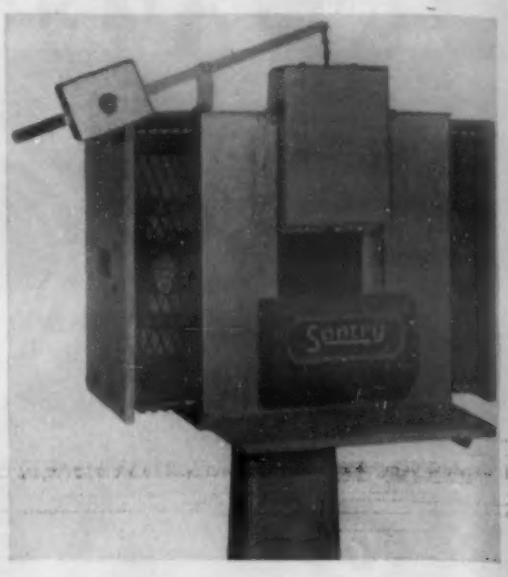
THE *Impressor*

For use on aluminum, aluminum alloys, and other "soft" metals, as well as plastics, hard rubber, and the like. Widely used in airplane and other war goods plants. Complete information and prices will be furnished promptly on request.

BARBER-COLMAN COMPANY
ROCKFORD • ILLINOIS

High-Speed Steel Hardening Furnace

A new electric high-speed steel hardening furnace, Size 2, Model Y, has been brought out by the *Sentry Co.*, Foxboro, Mass.



An asbestos loading shelf has been added to the front, and it is of an ample width and depth to permit easy arrangement of several furnace loads. New metal guards prevent accidental contact with live power supply.

● Three new circulating steam jets, efficient for heating acid solutions, dissolving powdered or lump chemicals and for the digestion of ores and separation of sludge acids, are introduced by the *Duriron Co.*, Dayton, Ohio. Made of high-silicon iron alloy, or special stainless steel, they are corrosion-resistant. They fit snugly to the inside walls of either square or circular tanks.

New Heat Exchanger Control

A new method of automatic temperature control for heat exchangers for industrial liquids is based on controlling the amount of outside air passed through the evaporative cooling chamber rather than altering the flow of liquid being cooled. This is incorporated into the Niagara aero heat exchanger, made by the *Niagara Blower Co.*, 6 E. 45th St., New York.

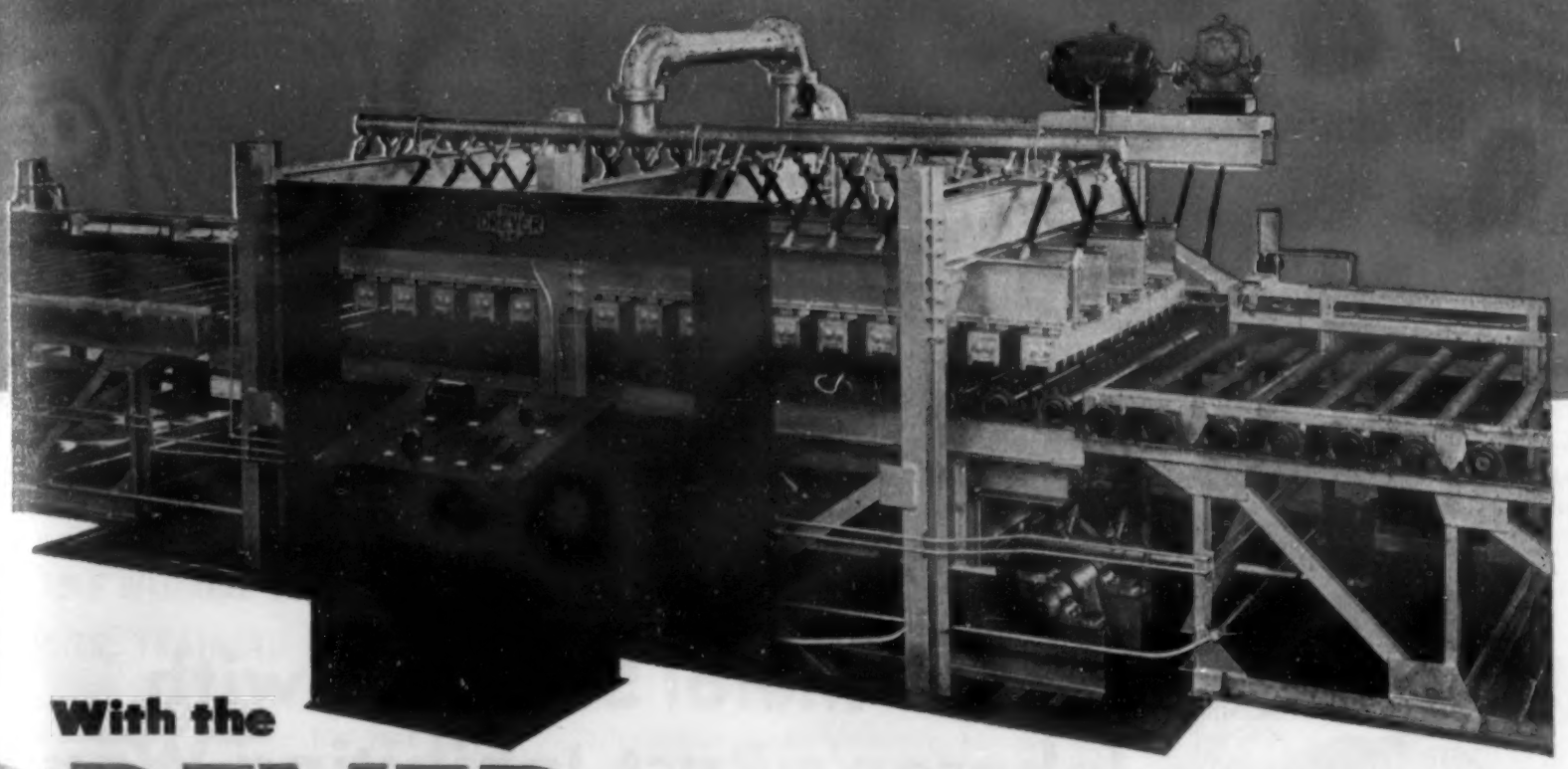
Accuracy is improved, with the cooling effect directly proportioned to load changes, giving a modulated, nearly straight line temperature control with no "hunting" action. Water savings are increased and, when used to cool oils or compounds, there is no settling of solids, restricted flow or clogging of tubes to interrupt operations.

Among the many fields where it is applied are heat treat quenching, wire drawing, cutting, grinding and machining coolants.

● A new machine prints color bands, insignia and other important data on cylindrical bodies of grenades, signal flares, cartridge cases, etc. It uses liquid inks, either dye or pigment colors, the inks being quick drying. It is made by *Jas. H. Matthews & Co.*, Pittsburgh, Pa.

Straighten AND QUENCH

ARMOR PLATE—ONE OPERATION!



With the

DREVER PRESSURE QUENCH

DREVER leads again with a *Straightening* quench that eliminates distortion of plates during quenching.

SIMPLE OPERATION

(1) Power driven rolls position plates in quench.

(2) Hydraulically operated lower platen lifts plates into contact with stationary upper platen.

(3) Platens hold plates rigid under proper pressure during complete water quenching cycle.

(4) Lower platen descends; allows quenched straight material to rest on motor driven rollers which remove plates from quench onto discharge table.

(5) No manual labor is required during entire straightening-quenching operation. All control is automatic from pulpit as illustrated.

Regardless of your present heat treating equipment, or your method of quenching, get the facts about the Drever Pressure Quench which *Straightens* the plates as it quenches. Write today.

EXPERIENCE POINTS TO THE DREVER CO

THE DREVER COMPANY

750 E. VENANGO ST., PHILA., PA.

News of Men, Societies, Meetings and Companies

Plants and Slants

Tommy Dorsey, "that sentimental gentleman," and Kay Kyser with his: "Good ev-en-in', folks, how-aa-you-all," help speed up production in five divisions of *Westinghouse* at East Pittsburgh. Assisting, too, are Harry James, Abe Lyman and Bing Crosby. Most of the girls in these de-

Records Produce Record Production

partments are between 19 and 24. Three stenographers take turns loading the automatic record player from a library of 500 recordings, with new records bought each month. Music is "piped" to loudspeakers in the shop. Each speaker has a rheostat to adjust the volume to the shop's noise conditions. The football season brings college songs; the Christmas season, carols. The swing seems to have that certain "thing" which keeps girls happy and speeds output.

Ceremonies in connection with awards of Army-Navy "E" emblems usually follow a cut-and-dried pattern. In the case of *Ilg Electric Ventilating Co.*, Chicago, John M. Frank, company president, mentioned in his speech of acceptance that not only does "E" stand for *e*xcellence, but also for the "*e*agerness, *e*nthusiasm, *e*nergy and *e*ndurance demonstrated in winning the honor by *e*ach and *e*very Ilg *e*mployee."

A new blast furnace was recently blown in by the *American Steel & Wire Co.* at Duluth, with capacity of 800 tons of pig iron daily. Blast furnace construction usually takes nearly two years to complete. In this instance the new addition at Duluth was completely dismantled at Joliet, moved 450 miles and rebuilt on modern lines in less than one year.

Employees often practice absenteeism because they observe their plants shutting down temporarily in the middle of an order, or working Sundays and holidays and remaining idle during some week days. So E. F. Fisher, general manager, *Fisher Body Div., General Motors Corp.*, Detroit, explained this seeming shiftlessness and erratic behavior to employees. He said: "We cannot operate in war on the 'steady flow' basis of peace. Frequently engineering changes are required immediately to meet changing conditions on fighting fronts. Frequently materials must be quickly transferred to other — and for the time being — more important projects. Sometimes schedule changes must be made in the middle of a day's production to meet an emergency requirement." Considerable editorial opinion was attracted to these remarks, and the reaction has been favorable.

The Majestic Co., Huntington, Ind., maker of metal building necessities, has purchased the *Brownie Mfg. Co.*, Fort Wayne, Ind., makers of clamps and turnbuckles.

Lukenweld, Inc., Coatesville, Pa., which

Protect Metal Surfaces with Johnson's Rust Inhibiting Waxes

•Today, rust is a real enemy of much war and other equipment. To help guard against it, the makers of Johnson's Wax have developed special Rust Inhibiting Waxes for use on untreated metal surfaces and on black oxidized and phosphated surfaces. These new waxes also provide a desirable *dry* finish. They are easy to apply, either by dip or spray methods. Coverage per gallon is excellent; drying is rapid.

Johnson's Rust Inhibiting Waxes are non-toxic, non-flammable. They are ready to use; no mixing or dilution is necessary.

Free test sample and full information gladly sent on request. Write

S. C. Johnson & Son, Inc.

Industrial Wax Division, Dept. MA43
Racine, Wisconsin
Canadian Address: Brantford, Ont.

★ BUY U. S. WAR BONDS AND STAMPS ★

Stuart's Thred Kut

AMERICA'S NO. 1 CUTTING OIL

PROVED ON THE TOUGHEST CUTTING JOBS . . .

"THRED-KUT" is tops where applications call for the "toughest" cutting oil. In diluted form it saves money on average and easy jobs. It is used in manufacturing armories, arsenals, munitions plants, aircraft plants and all other industries that demand the most modern cutting oil. A long list of leading machine tool builders recommend "Thred-Kut" — they want their machines to have every advantage.

For All Cutting Fluid Problems

D. A. STUART OIL CO.
Chicago, U.S.A. • LIMITED • Est. 1865

Warehouses in Principal Metal Working Centers

New Motion Pictures for Users of Steel

AVAILABLE WITHOUT CHARGE FOR GOVERNMENT USE, AIRPLANE PLANTS, TANK FACTORIES, TRAINING CLASSES AND ALL MAKERS OF COMBAT MATERIALS

Bethlehem Steel Company has just completed two motion pictures designed to assist metallurgists, producers and learners in plants making war materials.

The films have been planned, photographed, and edited under the supervision of leading technical men of the company.

The purpose of the films is to facilitate the efficient handling of steel in its conversion to war-time products.

The films, while simplified as much as possible for the comprehension of the learner, are not designed primarily for entertainment or popular educational value. Hence response to requests from general groups such as luncheon clubs and similar bodies, must be deferred pending our meeting requests from war plants and training schools.

WHAT THE PICTURES SHOW

The pictures are on 16 mm. film, with sound-track, each running for about 40 minutes. The subject matter includes the following:

STEEL FOR THE ARMED FORCES
PART 1
HOW STEEL IS MADE

Blast furnace, bessemer furnace and open-hearth operations.

Animated drawings of what takes place in the blast furnace and open-hearth.

Control of slag in the open-hearth.

Spectrographic analysis.

Still cross-sections of bessemer furnace, electric furnace, and cupola furnace in the foundry.

Standard rolling operations.

Hammer forges and press forges.

Iron and steel foundry.

STEEL FOR THE ARMED FORCES
PART 2
STEEL TREATING AND TESTING

Wire drawing.

Special testing procedures.

Close-ups of inspectors at work.

Preparation of steel for re-rolling.

Animated time-temperature charts showing heat treating sequences.

Standard spark testing procedure.

Stop motion photographs of sparks held at the characteristic point to indicate presence of various alloys.

PROMPT REQUESTS SOLICITED

We shall make as many prints as necessary to supply promptly the requests from war producing and training groups. To lower our costs, any such groups are asked to apply for showings promptly so that we may estimate the number of prints which may be needed.

We also have a film library of special-product pictures such as the making of wire rope. Typical groups before which Bethlehem films have been shown in the past year:

Vought-Sikorsky Aircraft Corporation
Union Carbide and Carbon Company
Fleet Service Schools, Norfolk, Va.
San Antonio Air Depot
Springfield Armory
Watervliet Arsenal
Princeton University
Henry Ford Trade School
Purdue University
Inspectors School of Naval Material
Pennsylvania State College
University of Pennsylvania
General Motors Institute
Rensselaer Polytechnic Institute
Frankford Arsenal
Cleveland Ordnance District
University of British Columbia
Virginia Military Institute
Springfield, Ohio, Foremen's Club
Foster Wheeler Corporation
Sun Oil Company

BETHLEHEM STEEL

HOW TO ORDER—*If you represent a war material plant or training group kindly write stating position, name of group, dates you desire the films and optional dates. State length of time you desire to hold prints. There are no charges except return expressage. Address Motion Picture Office, Room 841, Bethlehem Steel Company, Bethlehem, Pa.*

among other things fabricates welded parts used in the construction of propulsion equipment for Navy destroyers, increased production of these parts by 700 per cent during the fiscal year.

Whiting Corp., Harvey, Ill., announces that headquarters of its Canadian subsidiary has been moved to 45 Richmond St., West Toronto, where its newly elected vice president and general manager, H. M. Rowlette, will be in active charge. He succeeds Col. James Mess, who is now devoting full time to Government duties at Ottawa.

Pyrometer Instrument Co., 103 Lafayette St., New York, within less than one year has again doubled its floor space.

Parker Wire Goods Co., Worcester, Mass., has changed its name to *Parker Mfg. Co.* and is building an addition to its plant, costing $37,500.

Handy & Harman, New York, has opened a Los Angeles office in the Bendix Bldg., 1206 So. Maple Ave., in charge of H. A. Folgner.

United Precision Products Co. has moved into more spacious quarters at 3524 W. Belmont Ave., Chicago, which marks the third removal in the last five years.

Wickwire Spencer Steel Co. has formed a new subsidiary, *Wickwire Spencer Aviation Corp.*, with offices at 500 Fifth Ave., New York, and plants in Virginia and Illinois, the principal product being an automatic variable pitch propeller.

A second Meehanite manufacturer has been established in Southern Rhodesia, the *F. G. Issels & Son, Ltd.*, of Bulawayo, according to the *Meehanite Metal Corp.*, Pittsburgh.

Stroman Furnace & Engineering Co., Franklin Park, Ill., has become a division of the *Petersen Oven Co.*, with offices at 300 W. Adams St., Chicago, and a plant at Franklin Park, Ill.

New manufacturing plants and offices of *Plan-O-Mill Corp.*, formerly at Royal Oak, Mich., are now at 1511 East 8 Mile Road, Hazel Park, Mich.

Briefs on Associations, Promotions, Education

A unique savings plan to enable workers to start their own private business after the war is announced by the *Lincoln Electric Co.*, Cleveland. Among the suggested businesses are a commercial weldery, a commercial job welding shop or an automotive repair shop. The Cleveland Trust Co. is cooperating in the enterprise.

Mass production of passenger and freight cars of standard design may be realized in the post-war period, states Ellis W. Test, assistant to the president, Pullman-Standard Car Mfg. Co. Millions of dollars will thus be saved. Automobiles are made in advance of finding buyers, contrary to railroad equipment, but the latter will change. One of the most important post-war features will be reduction in weight of all types of railroad cars.

Among the topics that were scheduled to be discussed formally at the national meeting of the *American Society of Tool Engineers* at Milwaukee March 25-27 were: Machinability of metals, increasing tool life and tool salvage, the last embracing silver brazing, low-temperature brazing and cast high-speed welding rods.

Approximately 70 distinct types of brushing wheels have been assembled for permanent exhibit in the Smithsonian Institution at Washington by the Osborn Mfg. Co., Cleveland. A span of 50 years is represented. One brush used a half century ago consisted of wire radiating from a block of wood. Mounted on shafts, driven by steam, they were used by electro-platers and jewelers. One brush, of pliccord, is for working in acid pickling of copper and brass; another, of horsehair, to give extra-fine finish to certain metals; a third, a cord brush, removes molding "fins" from plastics; one of nylon is used with washing powders in industrial operations; a brush of horsehair and fine wire cleans small caliber guns.

As a result of renegotiation agreement, *Aluminum Co. of America* reduced prices for semi-fabricated and fabricated aluminum, effective last March 1.

Why is
METAL SPINNING
so important to
Industry Today?

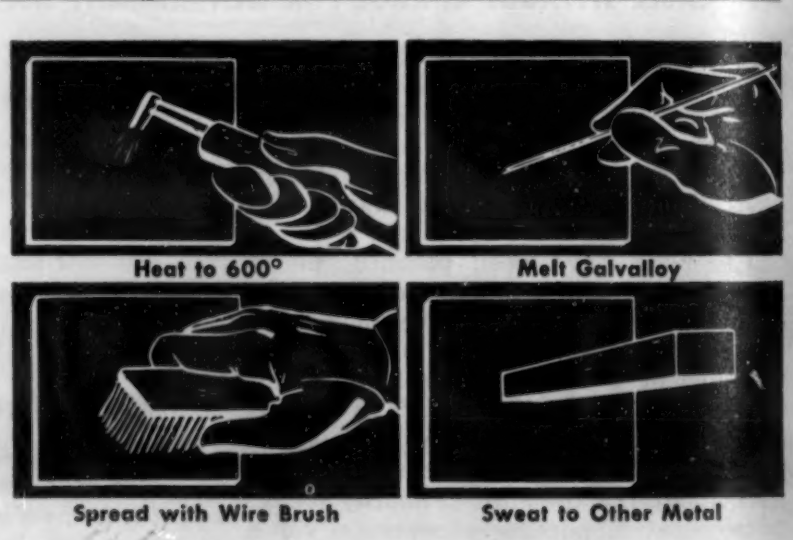
—it saves the cost of expensive tools—eliminates time-consuming tooling operations—gets your product into production much faster.

Spincraft is compiling valuable data which will show you how to apply the advantages of Spincraft's precise metal spinning. You need this information for your war and peacetime product design—it tears away the veil of mystery with which the ancient metal spinning craft has always surrounded itself.

Get on the mailing list by writing immediately for Bulletin A.

MILWAUKEE METAL SPINNING CO.
3508 West Pierce Street
MILWAUKEE, WISCONSIN

Spincraft
"SKILL WILL DO IT"



QUICK, SURE WAY TO
SOLDER ALUMINUM TO OTHER METALS

GALVALLOY provides a new easy and positive method for bonding aluminum and aluminum alloys to be soldered to other metals. GALVALLOY will bond to practically all types of metals. The only tool required is a welding torch. No flux is used.

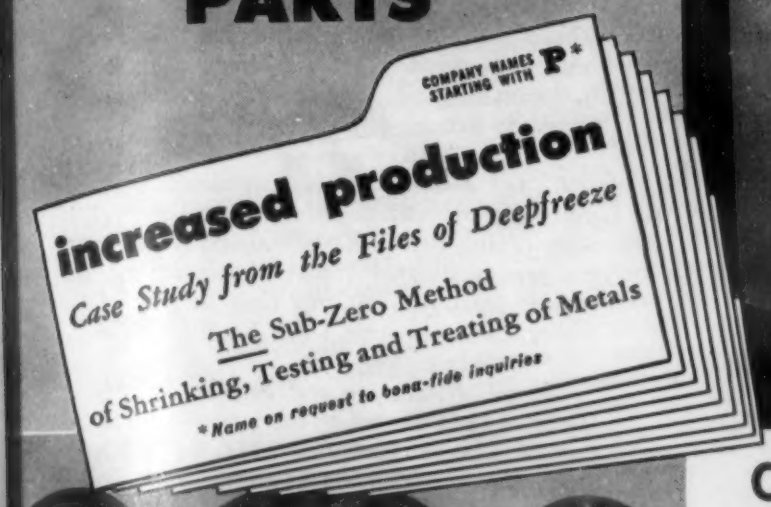
MANY OTHER USES FOR GALVALLOY

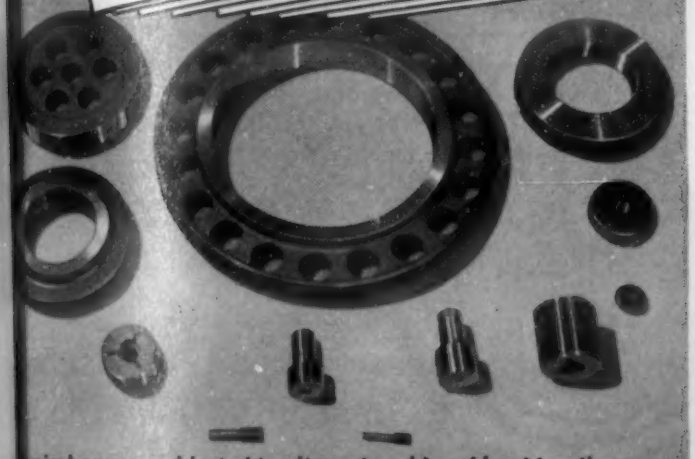
Fill blow holes or defects in aluminum and other castings, such as die plates in aircraft factories. Repair gas tanks, aluminum crankcases; fill welding seams; build up worn surfaces; protect galvanized steel from corrosion at points where the coating has been cut or burned off by welding.

GALVALLOY is supplied in triangular-section bars, 1/4" x 1/4" x 5/16" x 16" long, in any desired quantity, f.o.b. Los Angeles. For sample send $1.00 to cover handling, mailing and instructions. This material must be used only on implements of war, and orders must so specify.

METALLOY PRODUCTS COMPANY
P.O. Box 3093, Terminal Annex • Los Angeles California

HOW TO "Freeze" DIMENSIONS ON GAUGES AND PRECISION PARTS


COMPANY NAMES STARTING WITH P*
increased production
Case Study from the Files of Deepfreeze
The Sub-Zero Method
of Shrinking, Testing and Treating of Metals
*Name on request to bona-fide inquiries



Typical gauges subjected to alternate cold and heat treating

DATA AND PART INFORMATION

Reason gauges to prevent change in finished size.

Thread gauge treated as follows: 2 hours Deepfreeze— 2 hours boiling water — 2 hours Deepfreeze.

Other gauges treated according to gauge and steel. Some are heat treated one or more times or normalized between machining operations. Size determines number of Deepfreeze applications — larger gauges chilled more than once.

Sequence of Operations on Thread Gauge:

1. Machined, heat treated and rough ground.
2. Deepfreeze and heat treat.
3. Finish by lapping.

RESULTS: Gauges hold size in transit to customer's plant — no rejects.

SAVINGS: All time previously lost in correcting or replacing gauges whose size was distorted due to temperature changes and jarring.

FREE ADDITIONAL DATA . . . and proof of the outstanding success of the Deepfreeze method for chilling metals are included in this booklet. Write for *your* copy.

Operator Inserting Gauges in Deepfreeze Unit

Customers of Gauge Manufacturer Now Receive Gauges With Exact Dimensions as Shipped

This prominent manufacturer of gauges experienced difficulty in preventing growth or change in size of gauges during shipment to customers, and during later use in customers' plants. Jarring and temperature changes in transit affected finished gauge size and hours of careful work were wasted. When gauges were not distorted in transit, future metal growth and warp resulted in spoiled work in the customer's plant.

Alternate Cold and Heat Treating Assures Correct, Permanent Size

With the installation of Deepfreeze Industrial Chilling Equipment, together with usual heat treating, the gauges are now properly treated to hold finished size under all normal temperature changes and handling.

Gauges are stored 2 hours in Deepfreeze unit, then in boiling water, oil, or salt bath depending upon steel used, and then back to Deepfreeze storage for 2 additional hours.

The Uses of DEEPFREEZE in Your Plant

In addition to preventing growth or warp in gauges and precision parts, Deepfreeze metal chilling can help you in:

1—Shrinking of metals for ease of bearing assembly, etc.

2—Testing of metals for reaction of sub-zero temperatures to aircraft instruments, etc.

Investigate the full possibilities and application of Deepfreeze to your manufacturing . . . write for the booklet offered at the left.

Deepfreeze
DIVISION

MOTOR PRODUCTS CORPORATION
2330 DAVIS ST., NORTH CHICAGO, ILLINOIS

The discovery that gas dissolves in certain metals as salt dissolves in water may lead to the production of longer-lasting electronic tubes that will require less power to operate, Dr. Harvey C. Rentschler, noted physicist, recently told a meeting of the American Physical Society in New York. Gas particles of oxygen, hydrogen or nitrogen "loosen" the electrons, causing them to emit from metal more readily when heat or light is applied.

Cuyler S. Patton, *American Locomotive Co.*, has been elected president of the *Tubular Exchanger Manufacturers Assn.*, an organization which promotes the interests of users and manufacturers of heat exchange equipment, outlining best practices in design, engineering and manufacture.

No Westinghouse plant was shut down for a single day in 1942 because of disputes involving employees or management; nor because of lack of materials, though receiving 900,000 tons of steel, 27,500 tons of copper and proportionately large quantities of other materials from cotton thread to radium. Orders were 85 per cent over 1941.

Never before has industry paid so much attention to training new workers. Hundreds of excellent training systems could be mentioned. One that stands out is the "pays-as-it-trains" plan of the *Ohio Crankshaft Co.*, Cleveland. Trainees start in as regular workers at regular rates. The program aims to fit 2000 new workers, many from non-essential industries, into machine shop positions.

News of Metallurgical Engineers

C. R. Maxon, New Jersey Zinc Co., New York, has joined the War Metallurgy Committee, with headquarters at Washington, to carry out a special assignment.

James A. Davis, former metallurgist with the Colorado Fuel & Iron Corp., Pueblo, Colo., has been appointed to the technical staff of Battelle Memorial Inst., Columbus, where he will do metallurgical research related to the war. He received a degree in metallurgical engineering from the Colorado School of Mines.

L. G. Bean has been appointed vice president in charge of engineering and sales of the Bristol Co., Waterbury, Conn. He was graduated from Worcester Polytechnic Institute. At one time he was assistant chief engineer with the Bristol Co.

George W. Burpee and *Bradley Stoughton* have been elected to the board of directors of Lukens Steel Co. Mr. Burpee is a prominent consulting engineer, with extensive experience in the steel industry. Mr. Stoughton, a widely-known metallurgist and consulting engineer, has been professor of metallurgy at Lehigh University since 1923.

The Institute of Metals Medal, a British honor, has been awarded to *Dr. Harold Moore*, C.B.E., a fellow of the Institute, of which he was president in 1934-36, as one who has rendered "outstanding services to non-ferrous metallurgy."

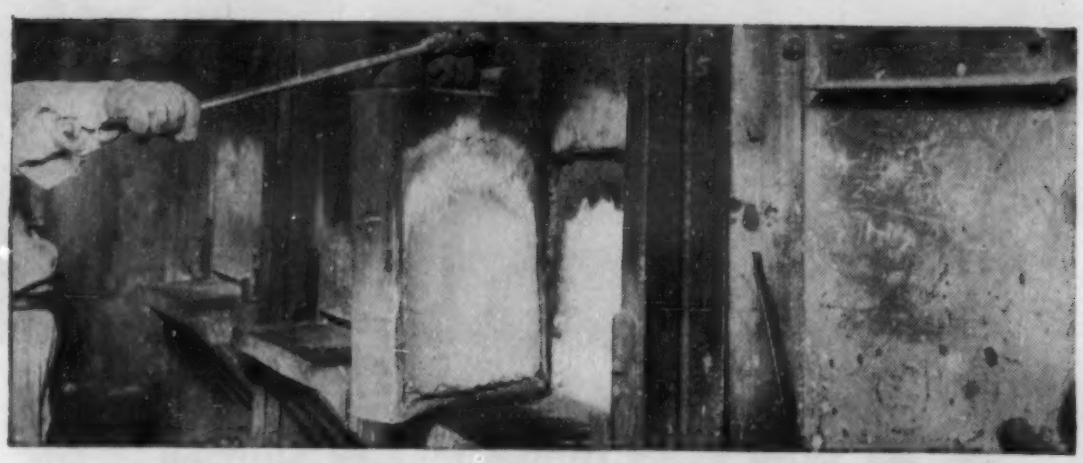
Cliff Schwenn has been made general superintendent of the Brillion Iron Works, Inc., Brillion, Wis. He has been with the Caterpillar Co., Peoria, Ill. for 14 years in a similar capacity.

Fred C. Smith has been named chief metallurgist with Tube Turns, Inc., Louisville, Ky. Previously he was field metallurgist with Carnegie--Illinois and prior to that was plant metallurgist for International Harvester.

Charles H. Manion, vice president in charge of operations of the Follansbee Steel Corp., Follansbee, W. Va., has been elected a member of the board of directors. He joined Follansbee as a designer in 1919. Among his positions with the company were maintenance engineer, efficiency engineer and chief engineer.

Folke Richardz, an engineer for 17 years with the Westinghouse Electric & Mfg. Co., has been appointed manager of engineering in the company's gearing department at the Nuttall Works, Pittsburgh, succeeding *S. L. Crawshaw*, resigned. He was graduated in 1921 from the Institute of

For 24-Hour Service on



Door Linings and Special Shapes

Cast them with J-M Firecrete

FOR SERVICE WITHIN 24 HOURS, you can cast furnace doors and linings, baffle tile, burner rings, pipe linings and special shapes *when you need them*—right in your own plant. Mix with water on the job. Firecrete provides negligible drying and firing shrinkage. Unusually resistant to spalling . . . assures long, efficient service with minimum maintenance.

FIRECRETE IS FURNISHED IN THREE TYPES. Standard Firecrete, for temperatures up to 2400° F.; H. T. (High Temperature) Firecrete, for temperatures up to 2800° F.; and L. W. (Light Weight) Firecrete, for temperatures up to 2200° F. For details on these three materials, write for brochure RC-13A. Johns-Manville, 22 East 40th Street, New York, N. Y.

JM

JOHNS-MANVILLE Firecrete

The Standard in Castables

HOW TO GET
VOLUME PRODUCTION
of Guaranteed Mg.-Al. Castings

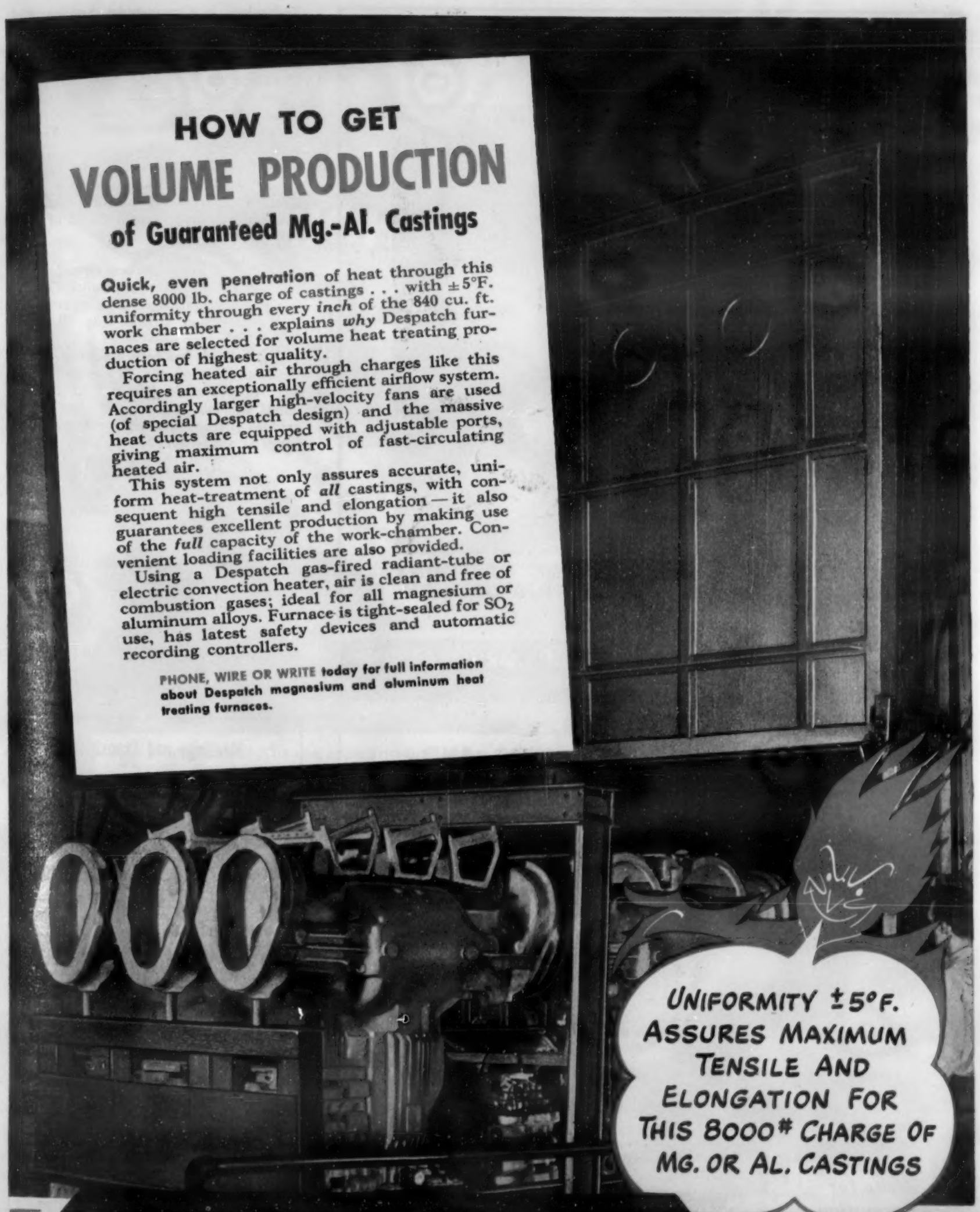
Quick, even penetration of heat through this dense 8000 lb. charge of castings . . . with ±5°F. uniformity through every *inch* of the 840 cu. ft. work chamber . . . explains *why* Despatch furnaces are selected for volume heat treating production of highest quality.

Forcing heated air through charges like this requires an exceptionally efficient airflow system. Accordingly larger high-velocity fans are used (of special Despatch design) and the massive heat ducts are equipped with adjustable ports, giving maximum control of fast-circulating heated air.

This system not only assures accurate, uniform heat-treatment of *all* castings, with consequent high tensile and elongation — it also guarantees excellent production by making use of the *full* capacity of the work-chamber. Convenient loading facilities are also provided.

Using a Despatch gas-fired radiant-tube or electric convection heater, air is clean and free of combustion gases; ideal for all magnesium or aluminum alloys. Furnace is tight-sealed for SO_2 use, has latest safety devices and automatic recording controllers.

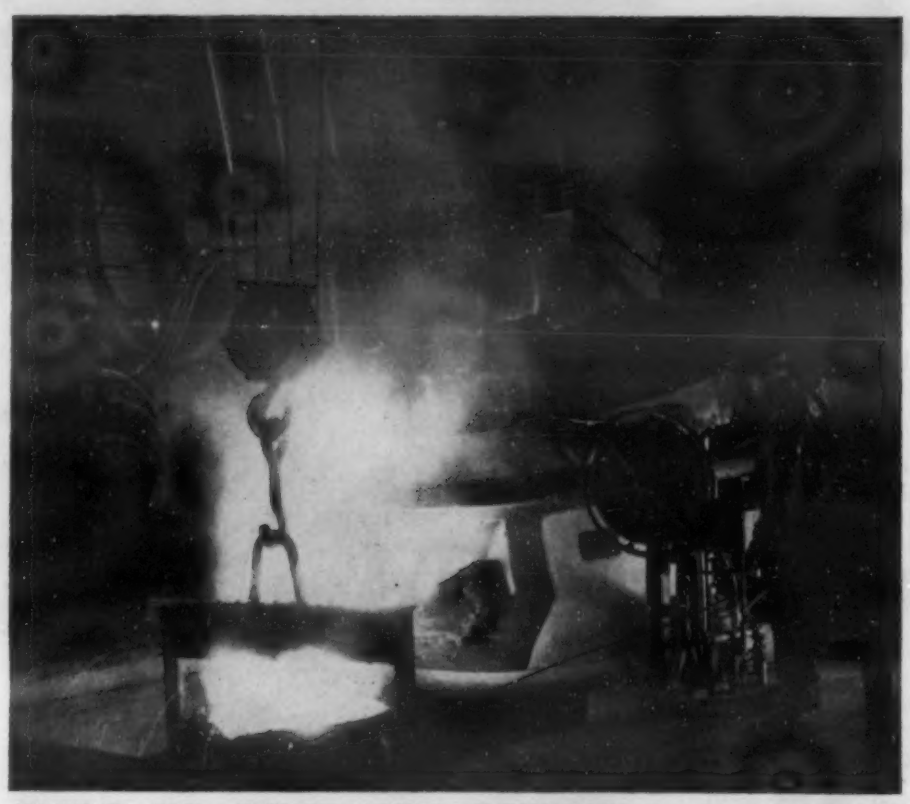
PHONE, WIRE OR WRITE today for full information about Despatch magnesium and aluminum heat treating furnaces.



DESPATCH
OVEN COMPANY MINNEAPOLIS

PROMPT DELIVERY
on well-rated orders

MOORE
RAPID *Lectromelt* FURNACES



BUILT TO MEET THE DEMANDS OF TODAY AND TOMORROW IN THE MELTING OF HIGHEST QUALITY ALLOY STEELS.

PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH, PENNSYLVANIA

Technology in Katerineholm, Sweden, with a mechanical engineering degree, and joined Westinghouse in 1926 as design engineer in the radio and photophone department.

Orville T. Barnett, engineer of tests for arc-welding electrodes, Metal & Thermit Corp., New York, has been made production engineer for both arc-welding and thermit welding divisions. He is a graduate of the Illinois Institute of Technology, and has previously been in charge of welding and shop inspection.

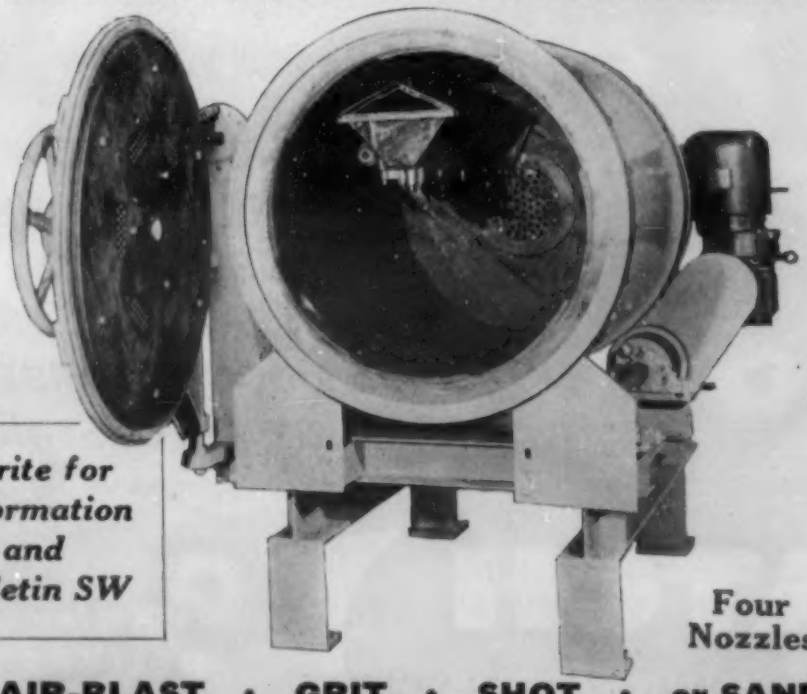
John F. Byrne has been elected to the vice-presidency of Koppers United Co. He is the general manager of Kopper's Blast Furnace Division, Granite City, Ill.

W. A. Steele has been appointed general superintendent of the Wickwire Spencer Steel Co.'s Buffalo Works. In 1923 he joined Crucible Steel Co., the year he was graduated from the University of Pittsburgh as a metallurgical engineer.

Raymond R. Ridgway, associate director of research for the Norton Co., has been awarded the Jacob F. Schoellkopf medal by the western New York section of the American Chemical Society. He is credited with the isolation and commercial production of boron carbide, used as a substitute for diamonds in drilling.

Dean A. Powers has joined the research staff of Battelle Memorial Institute, Columbus, to assist in the electrochemical and electrometallurgical research.

DESCALE HOT FORGINGS AND ANNEALED ARTICLES
Special Machines For
CARTRIDGE-SHELL CASES • CUPS AND FIRST DRAFTS
Barrel Type Machines For
SPRINGS • HEAT-TREATED STAMPINGS • CASTINGS
Bulk-Batch Cleaning—4 to 6 Cu. Ft. Per Charge
NO DELAYED PRODUCTION FOR REPAIRS!



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Meetings and Expositions

AMERICAN CHEMICAL SOCIETY, national meeting. Indianapolis, Ind. April 12-16, 1943.

AMERICAN CERAMIC SOCIETY, annual meeting. Pittsburgh, Pa. April 19-23, 1943.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION, spring meeting. Chicago, Ill. April 20-23, 1943.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Davenport, Iowa. April 26-28, 1943.

AMERICAN FOUNDRYMEN'S ASSOCIATION, annual meeting. St. Louis, Mo. April 28-30, 1943.

AMERICAN GAS ASSOCIATION, annual distribution conference. Cincinnati, Ohio. April 29-30, 1943.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Open Hearth and Blast Furnace Conference. Cleveland, Ohio. April 29-30, 1943.

AMERICAN GAS ASSOCIATION, joint production and chemical committee conference. New York, N. Y. May 24-25, 1943.

AMERICAN IRON & STEEL INSTITUTE, general meeting. New York, N. Y. May 27, 1943.

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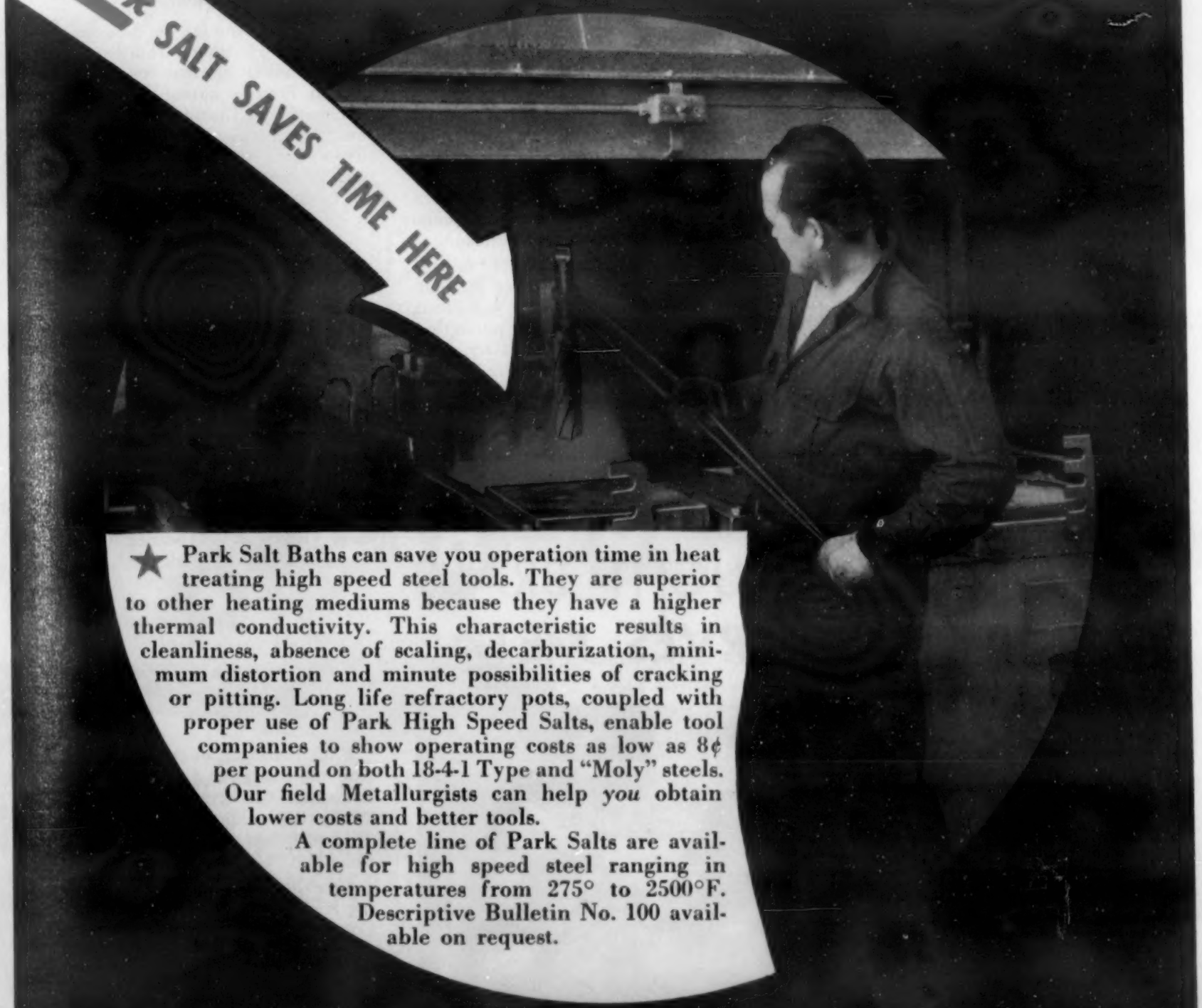

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ANNUAL CONFERENCE OF OPEN-HEARTH AND BLAST FURNACE OPERATORS

The annual meeting of the Open-Hearth Steel Committee and the Blast Furnace and Raw Materials Committee of the American Institute of Mining & Metallurgical Engineers is to be held in Cleveland this year on April 29 and 30 at the Hotel Statler.

This is the second time in 10 yrs. that this annual joint conference will have been held in that city. Cleveland is an ideal center for such a conference — the open-hearth and blast furnace capacity of that district is very large. The city leads the world in the production of nails, bolts and screws, malleable castings and heavy machinery. In normal times the value of the metals and metal products produced there is well in excess of $500,000,000 each year.

The Open-Hearth Committee held its second conference in Cleveland in the fall of 1925, with 25 men in attendance. Five years later, when the committee again met in that city, the attendance had expanded to 142. In 1939, when the conference was again held in Cleveland for the third time, the attendance was 525, including 45 blast furnace operators who by that time were meeting with the open-hearth group.

The program for this year's joint conference is patterned very much after those held in recent years. The sessions of the Open-Hearth Committee are held simultaneously with those of the blast furnace operators.

The Open-Hearth Steel Sessions

The Open-Hearth Conference opens at 9:30 Thursday morning with a half-hour General Open-Hearth Session at which Leo F. Reinartz, general chairman, National Open-Hearth Steel Committee, will deliver his address of welcome. The report of the McKune Award Committee and the reading of the McKune Award Paper is also scheduled for this brief session.

Basic Open-Hearth Practice

Following this general session is the Basic Open-Hearth Technical meeting, which holds three sessions, one for the balance of the morning and the other two during the afternoon. The general topic of the first session is "Personnel" with A. E. Reinhard, superintendent, Bessemer & Open-Hearth Departments, Youngstown Sheet & Tube Co., as chairman.

The first afternoon session, 1:30 to 2:55 p.m., is devoted to "Refractories and Furnace Maintenance," with John J. Golden, division superintendent of steel production, Carnegie-Illinois Steel Corp., Gary, Ind., in the chair. *"Keeping Open-Hearth Bottoms in Condition"* and *"Hot-Topping Steel"* are two of the topics to be discussed.

Following this session, from 3:00 to 5:30 p.m., is one devoted to "Operation of Open-Hearth Furnaces." Presiding over this is C. R. Fondersmith, American Rolling Mill Co., Middletown, Ohio, and among the topics to be brought up for discussion are: *"Maintenance of Equipment During Capacity Operations," "Present Status of Automotive and Other Open-Hearth Control Equipment," "How Do Substitute Fuels Affect Production Rate," "Method of Handling Large Chunks of Scrap,"* etc.

Acid Open-Hearth Furnaces

Simultaneous with the sessions on the Basic Open-Hearth on Thursday, there are two technical sessions on Acid Open-Hearth Practice during the morning and afternoon of Thursday, April 29. The morning meeting is devoted to "Maintenance of Acid Open-Hearth Furnaces" and the afternoon to "Practice and Quality." C. F. Christopher of the Continental Roll & Foundry Co., and E. W. Harder, of the Falk Corp., are chairman and co-chairman, respectively. Some of the topics scheduled for discussion include: *"Ladle and Pouring Practice," "Bottom Making and Furnace Repairs," "Foreign Acid Practice as Compared with American," "Control Methods in Making Acid Steel,"* etc.

Basic and Acid Open-Hearth Sessions

Friday, April 30, is devoted, both morning and afternoon, to "Basic and Acid Open-Hearth Sessions."

The morning session, with Harry Walther, Timken Roller Bearing Co., Canton, Ohio, as chairman, is devoted to Raw Materials. Some of the topics for discussion are: *"Use of Steel Turnings in Open-Hearth Furnaces," "Residual Metals in Scrap," "Use of the Spectrograph to Identify Non-Ferrous Metals," "Progress in the Reduction in the Use of Aluminum and Ferromanganese," "Reclamation of Scrap from Dumps,"* etc.

E. C. Barringer, of the Institute of Scrap Iron and Steel, and Edward Diebel, of the Industrial Conservation Section of the WPB, will address this session on the "Future Prospects of Scrap Iron and Steel Collection."

The afternoon session, the chairman being Harry L. Tear, Jones & Laughlin Steel Corp., is devoted to the general subject of "Quality."

Among the topics scheduled for discussion are: *"Manufacture of National Emergency (NE) Steels," "Technique of Adding Boron," "Description of Kaiser Open-Hearth Installation," "Addition of Deoxidizers to Last Ingots of Killed Steel to Prevent Fading,"* etc.

Blast Furnace and Raw Materials

The sessions of the Blast Furnace and Raw Materials Committee are held simultaneously with the Open-Hearth meetings on both Thursday and Friday mornings and afternoons.

The sessions on Thursday, April 29, are devoted to "Raw Materials," with H. A.

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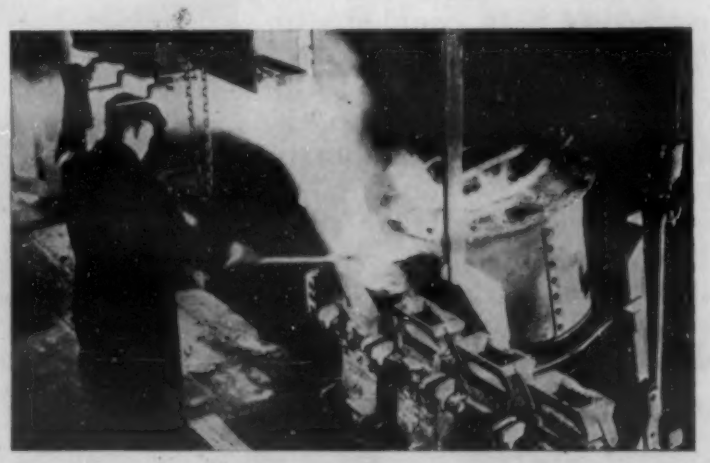

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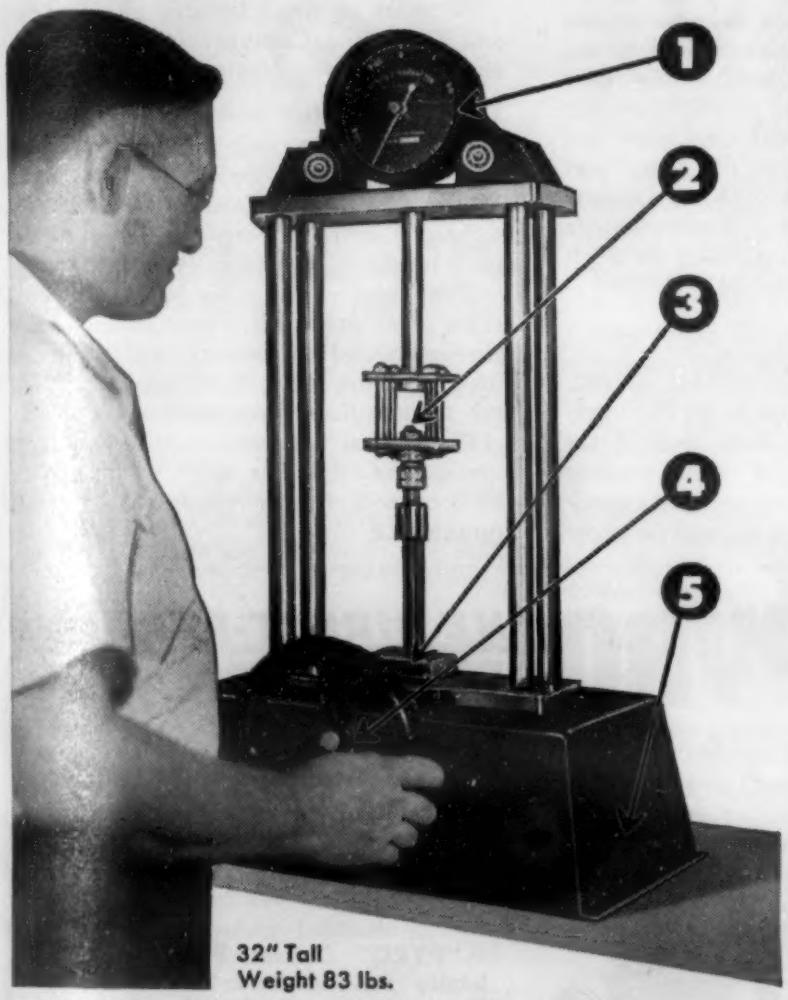

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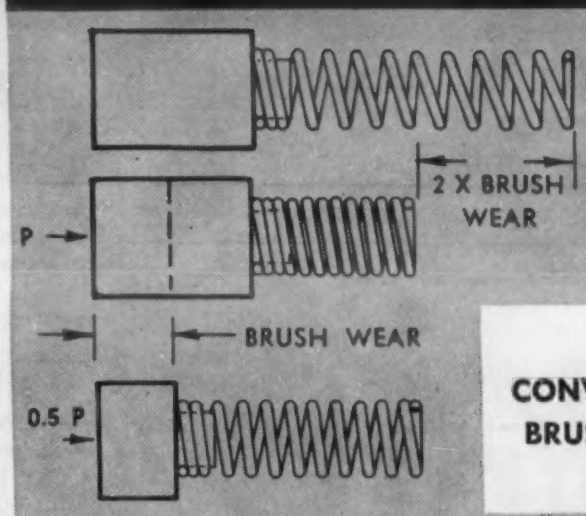

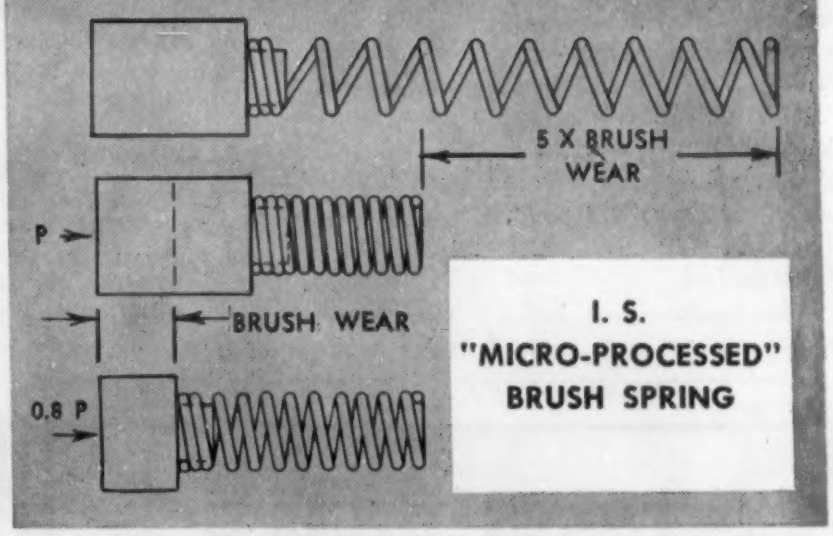

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"MICRO-PROCESSING MAKES THE DIFFERENCE"

Strain of the Carnegie-Illinois Steel Corp., Pittsburgh, as chairman. Three papers are announced for these two sessions: *"The Washing of Pittsburgh Coking Coals and Results Obtained on Blast Furnaces,"* by C. D. King, United States Steel Corp., Pittsburgh; *"Beneficiation of Mesaba Ores,"* by T. B. Counselman, The Dorr Co., Chicago; and *"Cornwall Ore Beneficiation,"* by A. F. Peterson, Bethlehem Steel Co., Lebanon, Pa.

The subject for the session Friday morning, April 30, is "Blast Furnace Construction." J. D. Jones, Youngstown Sheet & Tube Co., Youngstown, Ohio, is chairman. Two papers are scheduled for this meeting: *"Blast Furnace Pre-Construction,"* by B. M. Stubblefield, Youngstown Sheet & Tube Co., Youngstown, Ohio, and *"Relining and Enlargement of Johnstown 'G' Blast Furnace,"* by E. W. Trexler, Cambria Works, Bethlehem Steel Co., Johnstown, Pa.

For the session that afternoon, with G. W. Hewitt, Wheeling Steel Corp., Wheeling, W. Va., in the chair, the general topic is "Blast Furnace Operation." The two papers announced for presentation are: *"Design and Performance of Lackawanna 'H' Blast Furnace,"* by B. J. Harlan, Bethlehem Steel Co., Lackawanna, N. Y., and *"Effect of Screened Ore and Sintered Ore on Blast Furnace Operation,"* by R. A. Lindgren, Wisconsin Steel Works, South Chicago, Ind.

The luncheon and business meeting of this committee is to be held Friday noon, with Peter F. Dolan, Bethlehem Steel Co., Sparrows Point, Md., as chairman.

Annual Reception and Dinner

The annual reception and fellowship dinner has been arranged for Thursday, April 29, at 6:30 and 7:30 p.m. respectively. The reception is sponsored by the Open-Hearth Executive Committee. The toastmaster for the dinner is R. J. Wysor, president of Republic Steel Corp., Cleveland. H. G. Batcheller, director of the Iron and Steel Division of the WPB will be the principal speaker. The McKune Award will also be presented.

The Foundrymen's Annual Convention

The second "War Production Foundry Congress" of the American Foundrymen's Association will be held in St. Louis, April 28 to 30. There will be no exhibition in connection with this meeting, the time being solely devoted to a 3-day technical program. The headquarters of the Congress will be the Hotel Jefferson, where all sessions are scheduled.

On each day—morning, afternoon and evening—simultaneous sessions will be devoted to papers and symposiums on gray iron, steel, malleable and non-ferrous subjects. There are the usual sand shop and gray iron shop courses in the latter part of each day's program. The gray iron shop course will deal largely with cupola operation under the chairmanship of F. J. Walls of the International Nickel Co.

Two Symposiums

The symposiums are of decided interest. One is on "Gray Cast Iron as an Engineering Material," to which three sessions are allotted. The purpose of these sessions is to present information on the latest specifications and testing methods, and to show the many possible applications of various types of iron castings.

The other symposium is devoted to "Malleable Iron Melting," including discussions of various melting units, suitable refractories and so on. Three sessions are reserved for this. In addition, there will be an "off-the-record" round table devoted to special war problems.

A series of three lectures on "Heading and Gating of Castings" is scheduled for each of the three days at 4 P.M.

The Light Metals

Considerable prominence is devoted to the "light metals" under the sponsorship of the new Light Metal Div. Besides a technical session, there is also a round-table luncheon discussion and a shop course.

The usual round table luncheon discussions are provided for malleable iron, aluminum and magnesium, and steel castings. For the latter, three excellent technical sessions have been arranged.

The annual banquet is scheduled for the evening of the last day. Four special sessions will feature speakers of national prominence.

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trends

By Edwin F. Cone

Machine Tools

Some thoughts on the trend in the machine tool industry, particularly after the war, have been sent by the president of a large builder of such tools in a letter to his stockholders and they are worth repeating here in part. He said: "Unlike most items vital to the war, machine tools are not expendable in the war effort. If it should develop that the demand for turret lathes is not sufficient to utilize our full production facilities, we shall endeavor to undertake the manufacture of other items. Progress in this direction is already under way."

War Workers' Ideas

A trend of considerable interest and importance is the practice in many war plants of paying for war workers' production ideas. One company reports that such ideas or suggestions by workers saved 1,250,000 man-hrs. during 1942. A record $158,943 was paid last year for 16,204 suggestions adopted out of 53,945 submitted.

More Steel Plate

Output of steel plate continues to mount—a new record for any month was made in January at 1,135,400 net tons. The previous record was set in July 1942 when 1,124,118 tons were produced. Of the January total 566,000 tons were turned out by converted continuous strip mills.

Aluminum for 1943

The 1942 production of aluminum, according to Mr. P. D. Wilson of the WPB, was more than 3 times the 1939 output of 163,545 tons of primary ingot, all made by the Aluminum Co. of America. Including recoverable scrap and contracted ingot from Canada, the 1943 supply of the metal for the United States will be over 7 times that of 1939.

Earnings of Steel Companies

The trend of 1942 earnings of some of the leading steel companies has been downward as compared with 1941. For example the net income of the leading producer was 38 per cent lower last year than in 1941. Reported and estimated earnings for major producers indicate the industry's decrease will approximate 40 per cent. The principal reasons for this showing include increased labor costs and higher effective tax rates. Higher maintenance expenses due to continued peak operations are also a factor.

Stocks of Iron Ore

With the increased demand for pig iron and the building and enlarging of blast furnaces, stocks of iron ore at American and Canadian furnaces and at Lake docks have expanded to new totals. They aggregate 47,424,421 tons for the winter season compared with 40,456,893 tons a year ago. By May 1, this year, about 30,000,000 tons of this will be consumed, leaving only a moderate carry over.

The New Pennies

An electrolytically coated zinc sheet is being used by the Philadelphia Mint to produce the new pennies. A patented galvanized sheet was used initially, but the zinc coating clogged the dies,—another case of an electrolytic product being superior for some purposes to the galvanized. The case of tinplate is typical.

Electrolytic Tinplate

It is estimated that the total output of tinplate this year will run approximately 2,500,000 to 2,600,000 tons. No accurate estimate is possible as to what proportion of this will be made by the electrolytic process but there are those who rather reliably calculate that it will not be less than 40 per cent of the total. With all the principal makers of tinplate installing the electrolytic process, the expectation is that in 1944 at least 75 per cent of the total product will be made electrolytically.

Tin Consumption Down

"On the rough calculation that the tin coating of the hot dipped and electrolytic coated tinplate will average 1.1 per cent, the consumption of tin by the tinplate industry will be in the neighborhood of 6,000 tons during the first quarter of this year, or just about half the consumption per quarter in 1941."

Tin from Old Tubes

How much tin is being saved by turning in old toothpaste tubes, is a question often asked. The first authentic information we have seen has been given out by authorities who reveal that during October last year, these old tubes yielded 80 tons of tin.

Magnesium in 1943

The output of magnesium by the end of this year will be about 100 times the 3,350 tons produced in 1939, according to Phillip D. Wilson, chief of production, aluminum and magnesium div., WPB.